JOURNAL

OF THE

AMERICAN CHEMICAL SOCIETY.

VOL. XII.—NO. ~~11~~ 9

NOVEMBER,

1890.

COMMITTEE ON PAPERS AND PUBLICATIONS:

J. F. GEISLER,
A. C. HALE,
A. A. BRENEMAN, Editor.

ABSTRACTORS:

W. RUPP, J. F. GEISLER,
L. H. FRIEDBURG.

CONTENTS:

		Page
I.	Proceedings, November Meeting	423
II.	The Perissad Law. By Major W. R. Livermore, U. S. A.	426
III.	The Calculation of Blast Furnace Slags as Practised in certain Works in Europe. By Auguste J. Rossi	443
IV.	The Aeration and Composition of Niagara River Water above and below Niagara Falls. By Dr. Albert R. Leeds	449
V.	The Composition of Swill Milk. By Dr. Albert R. Leeds	451
VI.	A Note on Alum Phosphate Baking Powders. By L. H. Pitkin, Ph. B.	452
VII.	Notes on Water Analysis by the Ammonia Method, with some new Apparatus. By A. A. Breneman, S. B.	457
VIII.	Syntheses in the Sugar Group. By Emil Fischer. (Abstract). Translated by Dr. L. H. Friedburg	461
	Abstracts: General Chemistry	472
	Abstracts of American Patents relating to Chemistry	478

PUBLISHED MONTHLY.

NEW YORK:
JOHN POLHEMUS,
102 Nassau Street.
1890.

5236

The **Journal of the American Chemical Society** appears monthly, except during July and August. It will contain all papers read before the Society, as well as abstracts from American and Foreign Journals, and a list of American Patents relating to Chemical Industries.

The Price of Subscription is $5.00 per year, in advance.

The Meeting Room and Library of the Society are in University Building, Washington Square, New York.

The Regular Monthly Meeting is held on the first Friday of every month, at 8 P. M.

Corresponding Secretary:

A. C. HALE, 551 Putnam Ave., Brooklyn, N. Y.

Treasurer:

F. T. KING, 91 Columbia Heights, Brooklyn, N. Y.

The Library will be open to Members regularly on Fridays, from 7 to 10 P. M., and at any other time on presenting to the Janitor of the University Building a ticket, which can be obtained of the Librarian.

Back numbers of the Journal are sold to Members at $3.00, to others at $5.00, per volume. Apply to the Librarian

WILLIAM RUPP, 97 Water St., New York.

The Committee on Papers and Publications respectfully call attention to the resolutions of the Society, requiring that papers be submitted to the Committee before being read.

Authors will be furnished, gratis, with 20 reprints of each article published in the Journal, if application for the same be made when the article is sent.

Members are requested to give notice of any change of address, or failure in the delivery of the Journal. All communications relating to the Journal should be addressed to the Editor.

A. A. BRENEMAN, 97 Water St., New York.

Regular Meeting, November 7, 1890.

The minutes of the October meeting were read and accepted as read.

The following names were proposed for membership:

James E. Talmadge, D.S.D., Ph.D., Principal Latter Day Saints College, Salt Lake City, Utah.

J. A. Burns, Ph.D., Vice-Pres. and General Manager Tallapoosa Furnace Co., Tallapoosa, Ga.

S. G. Valentine, Colebrook Furnace, Lebanon, Pa.

H. F. Carpenter, Assayer, etc., 29 Page street, Providence, R. I.

W. C. Ferguson, Ph.B., Chemist Laurel Hill Chemical Works, 138 Wilson street, Brooklyn, N. Y.

Dr. J. H. Washburn, Kingston, R. I.

Harry Mullikin, Newport, R. I.

Dr. Edward P. Harris, Dept. of Chemistry, Amherst College, Amherst, Mass.

H. S. Patterson, 121 Pleasant street, Worcester, Mass.

Nathaniel J. Lane, Analytical Chemist, New York.

J. L. Perkins, " " "

J. A. Deghuée, 217 Harrison street, Brooklyn.

J. J. Tobin, U. S. N. Torpedo Station, Newport, R. I.

Harwood Huntingdon, Saylesville, R. I.

Mr. Walter M. Sanders, Hughesdale, R. I., was unanimously elected to membership.

The following papers were presented: "Note upon the Influence of Alum Phosphate Powders upon Digestion," by Lucius Pitkin, Ph. B., read by title.

"The Composition of Swill Milk," by Prof. A. R. Leeds.

"The Aeration and Composition of Niagara River Water above and below Niagara Falls," by Prof. A. R. Leeds.

"Calculation of Blast Furnace Slags," by Auguste J. Rossi, read by title.

Mr. A. Bourgouonon gave a synopsis of the last paper.

Mr. Rupp moved that the resolution adopted at the last meeting on the subject of the Philadelphia meeting be reconsidered. Carried. He then moved an amendment that the chair appoint a committee of five, of which the chairman of this meeting should be one, to take charge of the arrangements for the Philadelphia meeting. Carried. The chair named as the other members Messrs. Rupp, Chandler, Sabin, and McMurtrie. It was moved that this committee have power to enlarge their number. Seconded and carried. It was moved that the committee on the Annual Dinner be discharged and that the matter be referred to the committee of arrangements for the Philadelphia meeting. Seconded and carried.

The committee on nominations presented the official ballot for the annual election as follows:

Corresponding Secretary—A. C. Hale.

Recording Secretary—Durand Woodman.

Treasurer—F. T. King.

Librarian—William Rupp.

Curators—C. E. Munsell, J. Cawley, T. B. Stillman.

Committee on Papers and Publications—A. A. Breneman, J. F. Geisler, William Rupp.

Committee on Nominations—A. H. Sabin, A. P. Hallock, Lucius Pitkin, C. A. Doremus, J. B. Mackintosh.

Board of Directors.—Three Local Vice-Presidents, C. F. Chandler, L. H. Friedburg, R. W. Hall, A. A. Breneman, W. McMurtrie, A. C. Hale, F. T. King, E. Waller, A. H. Sabin, D. Woodman.

Advisory Council, for Three Years.—C. F. Chandler, T. G. Wormley, C. E. Monroe, J. H. Appleton.

For Two Years.—A. A. Breneman, F. A. Genth, A. B. Prescott, J. W. Mallet.

For One Year.—T. Sterry Hunt, S. W. Johnson, H. B. Nason, G. C. Caldwell.

It was moved that the order of the names presented for the Advisory Council be determined, as to tenure of office, at this meeting, by drawing by lot in two sets, the local names in one set, the non-local in another. Seconded and carried. The drawing resulted in the presentation of the names in the order given above.

The meeting was then adjourned.

CHAS. F. MCKENNA,
Recording Secretary.

MINUTES OF A MEETING OF THE BOARD OF DIRECTORS HELD NOVEMBER 6, 1890.

The meeting was held in the office of Prof. A. A. Breneman, 97 Water street, New York, and was called to order at 4:20 P. M.

Directors present were Messrs. Breneman, King, Geisler, Rupp, Kent, O'Connor and Hale.

Upon motion of Mr. Geisler, seconded by Prof. Hale, Mr. T. D. O'Connor was appointed auditor *pro tem.*, during the absence of Auditor Stebbins, now in Europe.

Upon motion of Prof. Hale, seconded by Mr. Rupp, it was declared to be the sense of the Board of Directors that all General Meetings should be regarded as *regular* meetings, and it was voted that the Board report this decision to the Society at its next regular meeting.

There being no farther business before the Board, upon motion of Prof. Hale the meeting was declared adjourned.

ALBERT C. HALE,
Secretary *pro tem.*

THE PERISSAD LAW.

By Major W. R. Livermore, U. S. A.

GENERAL OUTLINE.

The Perissad Law may be briefly explained as follows:

If the atomic weights of all chemical elements are arranged in a single ascending series, the law of increase is apparently irregular; but almost all of these weights may be so arranged in two parallel series, that each series will show a regular law of increase as far as the atomic weights have been determined, and in almost every instance all of one series fall into those groups of classification of Mendeleyeff that indicate an even quantivalence, and almost all of the others into those indicating an uneven quantivalence.

This realizes a prediction made by Dr. J. P. Cooke in 1854, as follows:

"The doctrine of triads is, however, as I hope to be able to show in the present memoir, a partial view of this subject, since these triads are only parts of series similar in all respects to the series of homologues of organic chemistry, in which the differences between the atomic weights of the members is a multiple of some whole number."

That paper speaks of the properties of the elements which are functions of the atomic weights, and says that "it does not seem bold theorizing to suppose that the atoms of the members of the same series are formed of a common nucleus, to which has been added one or more groups of atoms, or perhaps one or more single atoms, to which the corresponding element has not been discovered."

At the close of his paper of 1854 Professor Cooke said: "To my conceptions, chemistry will then have become a perfect science, when all substances have been classed in series of homologues, and

when we can make a table which shall contain, not only every known substance, but also every possible one, and when by means of a few general formulæ we shall be able to express all the properties of matter, so that, when the series of substance and its place in the series are given, we shall be able to calculate, nay predict, its properties with absolute certainty."

Although Cooke and Dumas were then working with a common aim, Dumas was not so confident of this ultimate solution of the problem in hand, for in 1857 he said : "I have often tried, as Mr. Josiah Cooke has on his part, to compare them, to combine them, and to discuss them with the hope of drawing some conclusion from th m with certainty, but I have been unable to draw from them anything but doubt. The formula deduced from the above simple progression," $(a+nd)$ "would not account for the generation of simple bodies, as Cooke had supposed." Dumas proposed a much more complicated formula, but that of Cooke is so far realized by the perissad law that out of the 54 elements embraced in the first eight series of Mendeleyeff, the atomic weights of 47 differ from the calculated value by less than three-quarters of a unit, 44 by less than half a unit, 39 by less than a third of a unit, 33 by less than a quarter of a unit, and 23 by less than a tenth of a unit.

When we consider the uncertainty in the determinations of many of those atomic weights that differ most from the regular increase, it may be admitted that Dr. Cooke's prediction has so far been verified that the formula $(a+nd)$ has been proved to lie at the bases of all classifications of atomic weights.

These determinations are not accurate enough to justify any conclusions about the deviations from the regular increase, but in general they appear to be additive in the case of those elements that show the greatest chemical activity, and these deviations may eventually help to determine the character of molecular forces.

The periodic law of Newlands and Mendeleyeff is valuable so far as it asserts that the properties of the elements are periodic functions of their atomic weights, but unsatisfactory and perhaps erroneously stated if it is pushed so far as to assert that the number of elements in each period is identical.

The Periodic Law has, I think, never afforded any means of predicting the exact atomic weight of a new element, nor has any law been suggested to account for the marked irregularity of the Mendeleyeff series. Newlands in particular has taken great pains to call attention to its irregularity, and most of its strongest advocates believe that there is an exceedingly complex law which regulates this increase. It is the object of this paper to show that the law is exceedingly simple.

ARRANGEMENT OF DATA.

In tabulating the atomic weights for this discussion it is better to base it upon the lists already published rather than to prepare one for the purpose by weighing the merits of each individual determination. Although the utmost accuracy is not attained by this empirical method, it will at least be free from any coloring, which it is so hard to avoid in comparing the result of observation with the requirements of a law that has already been formulated. In the *Journal of Analytical Chemistry*, Vol. III. (1889), page 58, in an article by Venable on the atomic weights, four such lists are prepared. Table I of this paper is prepared by taking in each case from the most recent lists, viz., those of Van der Plaats and Ostwald that determination which differs least from the older ones of Clark and of Meyer and Seubert, and taking account of the subsequent determinations that have been reported in the *Journal of Analytical Chemistry* or in the *Chemical News*, by taking the mean between the new values and those taken from the lists. The standard in all the tables is O = 16.

The new determinations thus considered are as follows:

Sn=	119.1	Bongartz and Classen	(J. A. C., III., p. 93).
Zn=	65.37	Gladstone and Hibbert	(J. A. C., III., p. 350).
Cr=	52.19	S. G. Rawson	(J. A. C., III., p. 350).
Zr=	90.62	Bailey	(J. A. C., III., p. 351).
Ru=	101.66	Joly	(J. A. C., III., p. 352).
Pd=	106.51	Keiser	(J. A. C., III., p. 352).
Mg=	24.29	Burton and Vorce	(Am. Chem. J., 12, p. 219).
Cu=	63.59	T. W. Richards	(Chem. N., 59, p. 179).

The determination of the relative atomic weights of hydrogen and oxygen, although it is, perhaps, the most important of all, does not affect this table in consequence of the isolated position of hydrogen.

To adapt the formula $a+nd$ to the series of atomic weights prepared in this manner, take the following values for a and d in the several series of common differences:

	First Series.		Second Series.	
	a	d	a	d
1st group	7.04	4.01	12.09	4.00
2d group	65.44	4.83	63.30	4.00
3d group	107.80	6.20	106.10	6.29

and let n represent the natural numbers 1, 2, 3, etc.

In Table I., column (2) shows the atomic weight, column (3) the difference between the successive terms of (2); columns (4) and (5), two parallel series of numbers in arithmetical progression, each term being placed on the line of that atomic weight which comes nearest to it in value. Column (6) shows the difference between the serial number and the atomic weight (except in the case of N, Ni and Ru, which form an independent progression with a common difference between 44 and 45; excepting also Be, whose apparent deviation from the law has not yet been explained, and Ge, Rh, and Ce, whose irregularity may arise from imperfect determinations of their atomic weights). Column (7) shows the number of the group in Mendeleyeff's arrangement to which each element belongs.

In Table II. the deviations from the regular increase have been arranged to correspond with the groups and series of Newlands and Mendeleyeff. The last line shows the algebraic sum of the deviations.

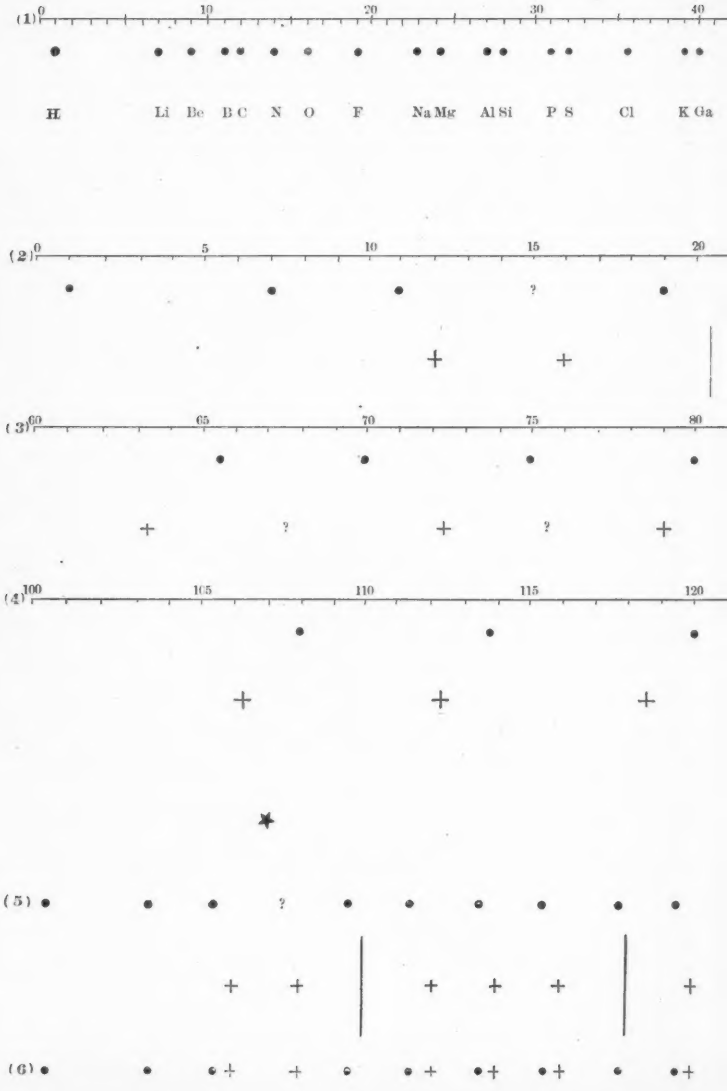
Plate I is a graphic representation of the series of atomic weights taken in a single series at (1) and in two parallel series at (2), (3), (4) and (5). At (6) the two parallel series are combined in one, but here the first series is represented by dots and the second series by crosses.

In (5) the asterisks represent the residual series N, Ni, and Ru.

COMPARISON OF CALCULATED AND OBSERVED VALUES.

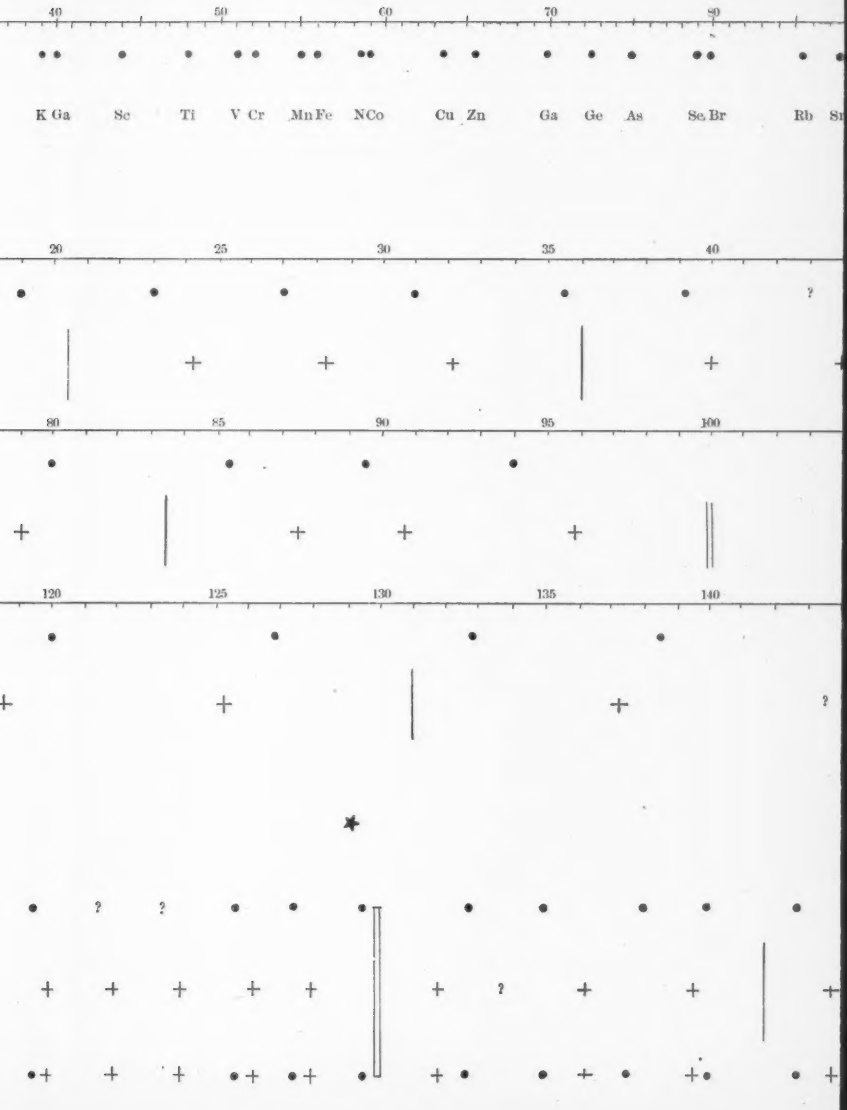
No regularity and no law is apparent in column (2) of Table I., or in line (1) of Plate 1. The differences in (3), Table I., range from 6.43 to 0.40. The mean of the differences is 2.79, and we find them distributed about as the theory of probability would lead us to expect from as many numbers scattered at random over the space, subject only to the condition that they should not differ by more than about 6 units from their nearest neighbors, excepting that among the lower numbers the fractions show a slight tendency to favor Prout's law. The average deviation from the mean difference is not far from 1.39 or half of 2.79.

The regularity of the double series, however, is quite apparent in Plate I., lines (2), (3), (4) and (5), and in (5) it is hard to detect with the eye that there is any irregularity whatever, excepting in the second group of the second series, viz., 63.46, 72.32, etc. From Column (6) Table I., and from Table II., it is seen that the deviations are inconsiderable. Their numerical value would average about .2, but in the lower numbers less than .1. The deviations from the two parallel series are as small as could be expected when it is considered that the four lists from which the table was prepared differ as much from each other as this series differs from the mean of all. The average range of values in the four lists would be about .3 of a unit and the new values for eight of the elements above mentioned determined within the past year, differ from those taken from the list by an average of .5 of a unit. These figures are of vital importance in their bearing on the significance of the law, which must not be classed with numerous approximate formulæ which have been suggested from time to time since the first publication of Dr. Cooke's paper in 1854.


(1)
0
10
20
30
40
H
Li
Be
B C
N
O
F
Na Mg
Al Si
P S
Cl
K Ga
(2)
0
5
10
15
20
?
(3)
60
65
70
75
80
?
?
(4)
100
105
110
115
120
(5)
?
(6)

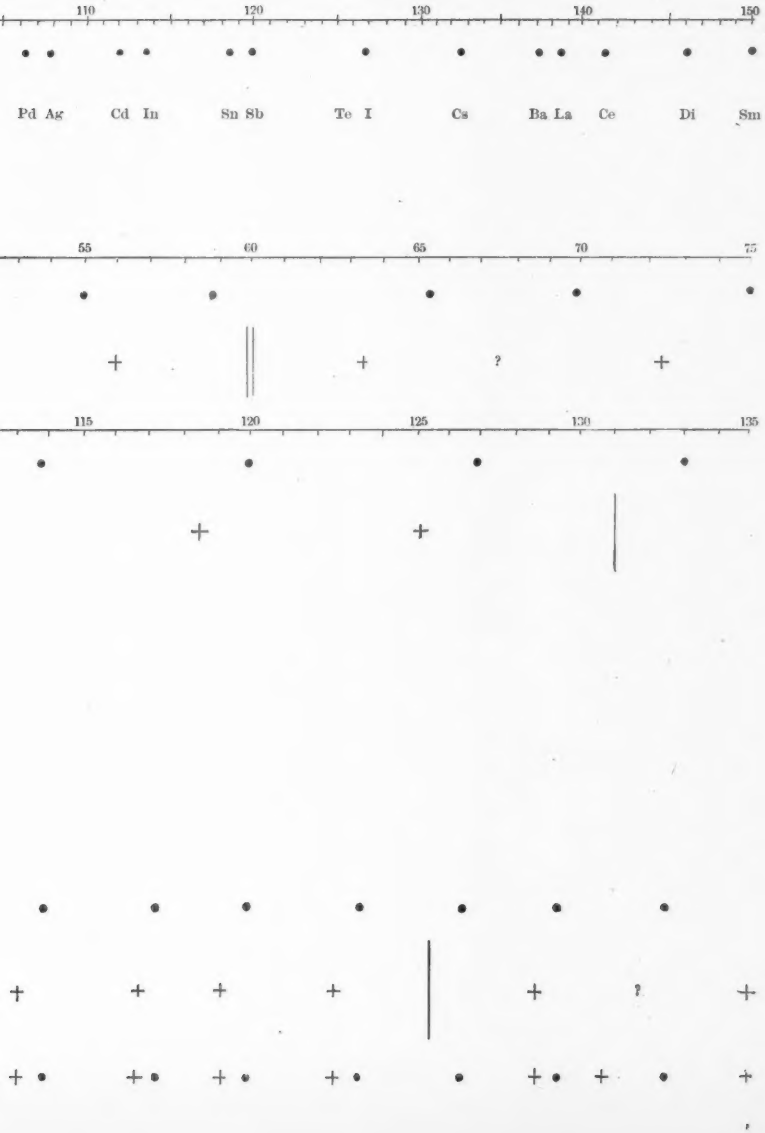
THE PERISSAD LAW.

PLATE I.



THE PERISSAD LAW.

PLATE I.


110
120
130
140
150
Pd Ag
Cd In
Sn Sb
Te I
Cs
Ba La
Ce
Di
Sm
55
60
65
70
75
?
115
120
125
130
135

THE PERISSAD LAW.

TABLE I.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	H	1.00	---	-----	-----	----	I.
		*	---	-----	-----	----	
First Groups of Perissad Law.	Li	7.03	6.03	7.04	-----	—.01	I.
	Be	9.10	2.07	-----	-----	----	II.
	B	11.00	1.90	11.05	-----	—.05	III.
	C	12.00	1.00	-----	12.09	—.09	IV.
	N	14.04	2.04	15.05	-----	----	V.
	O	16.00	1.96	-----	16.09	—.09	VI.
	F	19.01	3.01	19.06	-----	—.05	VII.
	**	*	*	*	20.09	*	
	Na	23.05	4.04	23.06	-----	—.01	I.
	Mg	24.33	1.28	-----	24.09	.24	II.
	Al	27.08	2.75	27.07	----	.01	III.
	Si	28.06	0.98	-----	28.09	—.03	IV.
	P	31.03	2.97	31.08	-----	—.05	V.
	S	32.06	1.03	-----	32.09	—.03	VI.
	Cl	35.46	3.40	35.08	-----	.38	VII.
	**	*	*	*	36.09	*	
	K	39.14	3.68	39.09	-----	.05	I.
	Ca	40.00	0.86	-----	40.09	—.09	II.
	—	-----	---	43.10	-----	----	
	Sc	44.08	4.08	-----	44.09	—.01	III.
	—	-----	---	47.10	-----	----	
	Ti	48.12	4.04	-----	48.09	.03	IV.
	V	51.30	3.18	51.11	-----	.19	V.
	Cr	52.25	0.95	-----	52.09	.16	VI.
	Mn	55.00	2.75	55.12	-----	—.12	VII.
	Fe	56.00	1.00	-----	56.09	—.09	VIII.
	Ni	58.40	2.40	-----	-----	----	VIII.
	Co	58.80	0.40	59.13	-----	—.33	VIII.
Second Groups.	Cu	63.46	4.66	-----	63.30	.16	I.
	Zn	65.44	1.98	65.42	-----	.02	II.
	—	----	---	-----	67.30	----	
	Ga	69.90	4.46	70.25	-----	—.35	III.
	Ge	72.32	2.42	-----	71.30	----	IV.
	As	75.00	2.68	75.07	75.30	—.07	V.
	Se	79.00	4.00	-----	79.30	—.30	VI.
	Br	79.95	0.95	79.90	-----	·05	VII.
	**	*	*	*	83.30	*	
	Rb	85.44	5.49	84.72	-----	.72	I.
	Sr	87.52	2.08	-----	87.30	.22	II.
	Y	89.50	1.98	89.55	-----	—.05	III.
	Zr	90.56	1.06	-----	91.30	—.74	IV.
	Cb	94.00	3.44	94.37	-----	—.37	V.
	Mo	95.90	1.90	-----	95.30	.60	VI.

TABLE 1—*Continued.*

THIRD GROUPS.	Ru	102.33	6.43	-----	-----	---- VIII.
	Rh	104.00	1.67	-----	-----	---- VIII.
	Pd	106.21	2.21	-----	106.00	.21 VIII.
	Ag	107.93	1.72	107.80	-----	.13 I.
	Cd	112.08	4.15	-----	112.29	—.21 II.
	In	113.70	1.62	114.00	-----	—.30 III.
	Sn	118.50	4.80	-----	118.58	—.08 IV.
	Sb	120.00	1.50	120.20	-----	—.20 V.
	Te	125.20	5.20	-----	124.87	.33 VI.
	I	126.86	1.66	126.40	-----	.46 VII.
	**	*	---	-----	131.16	*
	Cs	132.90	6.04	132.60	-----	.30 I.
	Ba	137.10	4.20	-----	137.45	—.35 II.
	La	138.50	1.40	138.80	-----	—.30 III.
	Ce	141.50	3.00	-----	143.74	---- IV.
	Di	1 5.00	3.50	145.00	-----	.00 V.
	Sm	150.10	5.10	----	150.03	.07 VI.

TABLE II.

Deviations.

Group Series.	I.	II.	III.	IV.	V.	VI.	VII.
2 ----	—01	-----	—05	—09	----	—09	—05
3 ----	—01	+24	+01	—03	—05	—03	+38
4 ----	+05	—09	—01	+03	+19	+16	—12
5 ----	(+16)	(—02)	—35	----	—07	—30	+05
6 ----	+72	+22	—05	—74	—37	+60	----
7 ----	+13	—21	—30	—08	—20	+33	+46
8 ----	+30	—35	—30	----	+00	+07	----
Total-	+19	—03	—15	—18	—03	+11	+14

The groups and series of this table are those of Mendeleyeff's Periodic law.

For example, L. Meyer (Modern Theories, Eng. trans. p. 162), says: "An examination of the atomic weights of the following groups of elements shows the differences of the atomic weights of their members to be approximately the same.

	Dif.		Dif.	
Fe = 55.9	47.6	Ru = 103.5	95.1	Os = 198.6
Co = 58.6	45.5	Rh = 104.1	88.6	Ir = 192.7
Ni = 58.6	47.6	Pd = 106.2	88.1	Pt = 194.3
Cu = 63.2	44.5	Ag = 107.7	88.5	Au = 196.2
Zn = 64.9	46.8	Cd = 111.7	88.1	Hg = 199.8
Ga = 69.9	43.5	In = 113.4	90.3	Tl = 203.7
———	——	Sn = 117.4	89.0	Pb = 206.4
As = 74.9	47.1	Sb = 122.0	88.0	Bi = 210.0
———	45.1	Sb = 120.0	87.5	Bi = 207.5

"In the case of osmium, however, its atomic weight appears to be some six or seven units too large, whilst that of indium appears about two units too small. No conclusion can be drawn as to whether the atomic weight of antimony is 120, as found by Schneider and confirmed by Cooke, or whether it is 122, as found by Dexter and confirmed by Kessler.

"Although the difference between the atomic weight of arsenic and antimony is 47 when the number 122 is accepted, yet the latest determinations of Cooke show that the number 120 is to be preferred.

"It may, however, be safely asserted that should Schneider's number prove to be correct, his determination of the atomic weight of bismuth, viz. Bi = 207.5, is probably correct, whilst Dexter's atomic weight of antimony is only adapted to Dumas' atomic weight of bismuth, viz. Bi = 210."

But these comparisons deal with units rather than with tenths and hundredths. Meyer continues:

"The relations of the differences between the atomic weights justify us in making a selection from different experimental results; still our knowledge is too uncertain to allow of theoretical adjustments of numbers obtained by experiments. There can be no doubt that these differences are subject to law."

Mendeleyeff, in his Faraday lecture (*Jour. Chem. Soc.*, **55.**, *641*) says:

"In the theory of numbers only do we find problems analogous to ours, and two attempts at expressing the atomic weights of the elements by algebraic formulæ seem to be deserving of attention, although neither of them can be considered a complete theory, nor as promising finally to solve the problem of the Periodic Law. The attempt of E. J. Mills (1886) does not even aspire to attain this end. He considers that all atomic weights can be expressed by a logarithmic function,

$$15\ (n—0.9375^{t})$$

in which the variables n and t are *whole numbers.*"

By this formula the atomic weights of the first 10 elements differ from the calculated values by a little less, and the next 20 elements by a little more than numbers selected at random.

Another logarithmic formula is that of Dr. G. J. Stoney. An abstract of his paper published in the Chemical News (**57.**, 163, 1888), and in other periodicals, says that in plotting the atomic weights as ordinates of a diagram, the effort to extract information from the resulting curves was a failure. In plotting their cube roots, however, he found two logarithmic curves with perturbations, which showed distinct laws of increase for perissads and artiads. That for the perissads is expressed as follows:

$$Ym = k\ \log\left[a\ (m + \tfrac{1}{3}\sin\frac{m\,\pi}{27} + \tfrac{1}{3}\sin\frac{m\,\pi}{18} + \text{subsequent terms})\right]$$

the next being probably either $—\frac{1}{2}\sin\frac{m\,\pi}{9}$, or $—\frac{2}{3}\sin\frac{m\,\pi}{9}$.

This is a much more complicated expression than Cooke's original formula $(a+nd)$ which appears to be far more significant in its bearing upon the question of the structure of atoms.

Moreover with all the perturbations, the calculated values do not appear to coincide with the observed values as closely as those of the Perissad Law.

An "Approximate Algebraic expression of the Periodic Law of the Chemical Elements," by Prof. Carnelly, was published in

the Philosophical Magazine as recently as January, 1890. Prof. Carnelly says: "In 1885 I proposed for the chemical elements the general formula.

$$A_n\ B_{2n} + (2 - x)$$

in which n is the series and x the group to which the element belongs; A = 12 and B = −2.

"Since that time, and for the thirteen years previously, I have made frequent attempts to find a simple numerical expression for the Periodic Law, but so far without marked success. Early in the past summer, however, I obtained an expression, which, though only approximate, may still be found of considerable interest." This expression takes the form

$$(6.6\ m + \sqrt{v})$$

in which m denotes the series and v the number of the group of Mendeleyeff's classification.

The deviations from his calculated values range from 0.1 to 6.7. Their mean value is 1.9, and 33 out of 54 are greater than unity.

The Rev. Dr. Haughton has perhaps done as much as any one to call attention to this important problem of representing the relation of atomic weights by algebraic expressions, and his well known geometric illustrations cannot fail to be both interesting and instructive to students of chemistry and mathematics.

Dr. Haughton calls attention to the constant increase of the artiad series from C to Si by locating them upon the same straight line in his diagram, which also shows the break in the series between O and Mg where his straight line crosses the axis.

RESULTS OF COMPARISON.

Referring to column (7) Table 1 showing the group in the Mendeleyeff series to which the element belongs and bearing in mind that Groups I., III., V. and VII. of this series correspond to the perissads and II., IV., VI. and VIII. to the artiads, it appears that all of the first series of regular increase are perissads except Co and Zn, and all of the second series are artiads except Sc and Cu of these, Cu and Zn are connecting links between the first and second groups.

Co perhaps belongs to another series, and Sc is little known.

The first groups of the first and second series have the common difference of 4.01 and 4.00 respectively. Their first terms are 7.04 and 12.09. Hence it follows that the difference between any term of the first series and the next term of the second should be about a unit. This is true for seven couples, and only fails where a term is missing from one of the series. In the same manner the difference between any term in the third group of the second series and the next term of the first series should be about one and a half units. Nothing can be predicted about the relation between the second groups owing to the irregularity of the second series in that group.

Comparing the second series column (5) Table 1 with the last of atomic weights in column (2) we find no element corresponding to the terms 20.09, 36.09, 83.30 and 131.16, nor is it probable that an element will be discovered with an atomic weight corresponding to these numbers, for the reason that they occur at that place in the series where the change from electro-negative to electro-positive occurs.

No element corresponds with 63.30, but the second group of the second series to which this term belongs is so irregular that it would be unsafe to base any prediction upon the common difference assumed for this series. More accurate determinations of some of the atomic weights of this group are much to be desired.

If praseodymium maintains its claim to a place in the series with an atomic weight of 143.6, it corresponds with the term 143.5 better than cerium.

The determination Sc=44.08 brings it in the second series with the artiads, although it is regarded as a triad. It is not impossible that subsequent determinations may find a value nearer to 43.10, its calculated place in the first series. If philippium has a place in the series it should lie between 45 and 48* and perhaps correspond to 47.10, leaving 44 or 43 for some other element. If it can be demonstrated that any other atomic weight than that of scandium lies between 40 and 48, the law of the octaves will have to be stated in broader terms than heretofore.

*Crooke's Researches on the Rare Earths, *Chem. News*, **60**, 28.

The Perissad law would thus hold true if two more elements were inserted in the fourth series of Mendeleyeff than are provided for therein.

Whether the eighth group of Mendeleyeff should be associated with that group of common differences which precedes or with that which follows it, remains to be determined. It is also uncertain whether terms will ever be found between the several groups of constant increase near the atomic weights, 60 and 100.

The position of tellurium in the series has always been unsatisfactory. The old value was about 128, which is greater than that of iodine, whereas analogy would make it less.

Brauner has worked hard to find the true value. He is not yet satisfied with his results, and asks his brother chemists to leave the problem to be worked out by him. (*Jour. Chem. Soc.*, **55**, 411—July, 1889.)

He says: "According to the recent determinations made by J. P. Cooke as well as those of Stas, these elements have the following atomic weights, Sb=119.96 and I=126.86, and we may therefore expect that the atomic weight of tellurium will be still smaller than 125, namely, about 123.5."

This is only another illustration of the fact that the Periodic law furnishes no guide whatever to determine the exact value of atomic weights. The Perissad law would give the following value for tellurium, viz.: 124.87+.11=124.98. This value depends, however, upon that of the other six elements in the third group of the second series, which are not as well known as those of the first groups.

INFERENCES.

The deviations from regular increase cannot be expected to correspond in every case with the chemical and physical properties, and in the present state of knowledge it would be impossible to form any conclusion from such comparisons, which, nevertheless, are valuable in the way of suggestion.

Table II. shows that in groups I. and VII. of the Mendeleyeff classification, the atomic weights found by observation are on an average in excess of those obtained by calculation.

In a general way the elements whose deviations are positive are chemically active, readibly fusible, strongly electro-positive or electro-negative, and have the greatest atomic volumes. On the other hand those whose deviations are negative, are chemically and electrically neutral, are fusible only with great difficulty, and have small atomic volumes.

The general bearing of the Perissad Law upon the structure of atoms cannot be stated in better terms than those of Dr. Cooke, quoted at the beginning of this paper, viz.: "that the atoms of the members of the same series are formed of a common nucleus, to which has been added one or more groups of atoms, or perhaps one or more single atoms to which the corresponding element has not been discovered."

The law has been suggested to the writer of this paper as follows:

A mathematical analysis of molecular forces shows that if gravitation is the controlling force at minute as well as at sensible distances, then it must follow that the particles of which an atom is composed are to a great extent arranged in lines and not scattered promiscuously nor homogeneously through the space occupied by the atom. In other words matter must be fibrous or reticular, having a skeleton or frame work which holds together the mass, which is perhaps surrounded by an atmosphere of ether. This supposition is not so improbable as to be dismissed without due investigation. If the skeleton is composed of particles in rapid motion, in orbits nearly rectilinear, and if the surrounding ether is of a discontinuous nature and also in rapid motion, these motions are sufficient to counterbalance the tendency to collapse due to the force of attraction.

Whether this or any other of the assumptions about the constitution of matter be true, both the Perissad and the Periodic Law have an important bearing upon the problem.

Whatever opinion may be held with regard to the genesis of chemical atoms there can be no question that the masses vary according to some law.

Perhaps, for instance, an atom of aluminium has been formed by the addition to an atom of sodium of one or more other particles having a weight of four, perhaps by addition to one of magnesium

of a weight of three, or to one of boron of a weight of sixteen; perhaps on the other hand an atom of sodium has been formed by the loss of a weight of four from one of aluminum, etc. In all these cases the structure may be regarded as the same, and the phenomena may be investigated by treating a heavier atom as composed of a lighter one with something added to it. The above supposition, however, is at variance with that which assumes that the several atoms are composed of essentially different substances. The question of the constitution of matter is one of vital importance to the science of chemistry and can only be solved by a systematic course of investigations. On this point Victor Meyer in his address at Heidelberg, Sept. 18 1889, says :

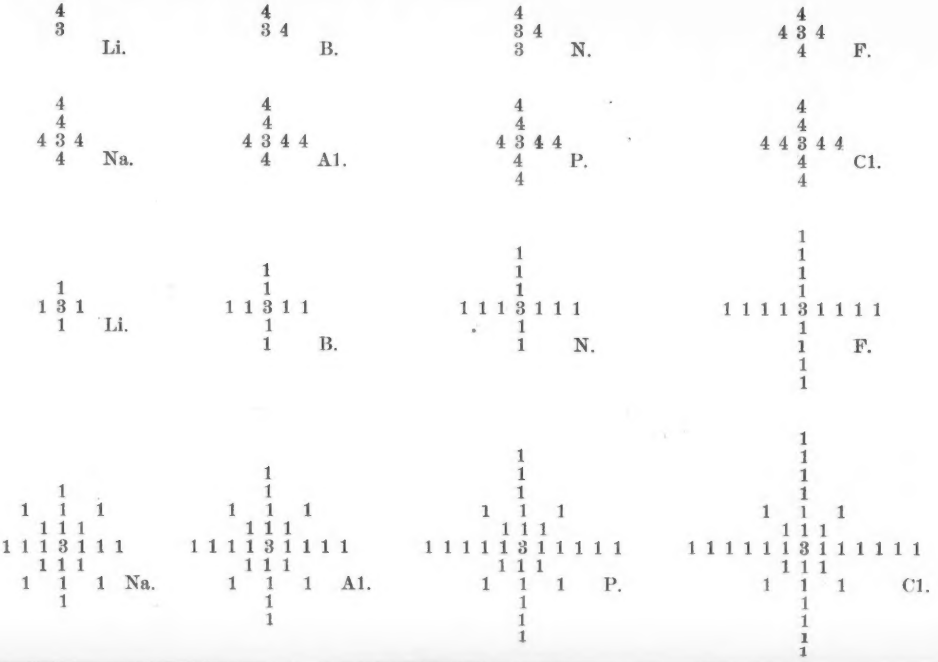
" Has it not been in our own day that the most prominent orator amongst German naturalists, one who astonishes us by the comprehensiveness of his knowledge, has adopted as his own Kant's judgment on chemistry, namely, that 'chemistry is a science, but not a science in the highest sense of the word, that is, a knowledge of nature, reduced to mathematical mechanics.' * * *

" If, without question, it is the aim of all natural science to understand phenomena so fully that they may be describedin a mathematical form and, as far as they are unknown, may be predicted, a science which is so far distant from this aim as to look merely for the *path* that shall some day lead to it, must be considered as in its infancy. In the present stage our way of thinking and acting has this peculiarity. * * * Before we can arrive at a mathematico-physical treatment of chemical phenomena in general, two fundamental problems must be solved ; an hypothesis which allows a control by experiment (even within the same limits which to this day are imposed upon physics in regard to the law of gravitation), must answer these questions :— *What is Chemical Affinity?* and *what is Valency?*"

Two paths are presented and each should be pursued until it leads to an improbable conclusion, or furnishes a further clue to the solution of the problem.

The first path above mentioned appears far more promising, and the bearing of the Periodic and Perissad Laws upon this problem can be explained by a general illustration as follows :

PLATE II.



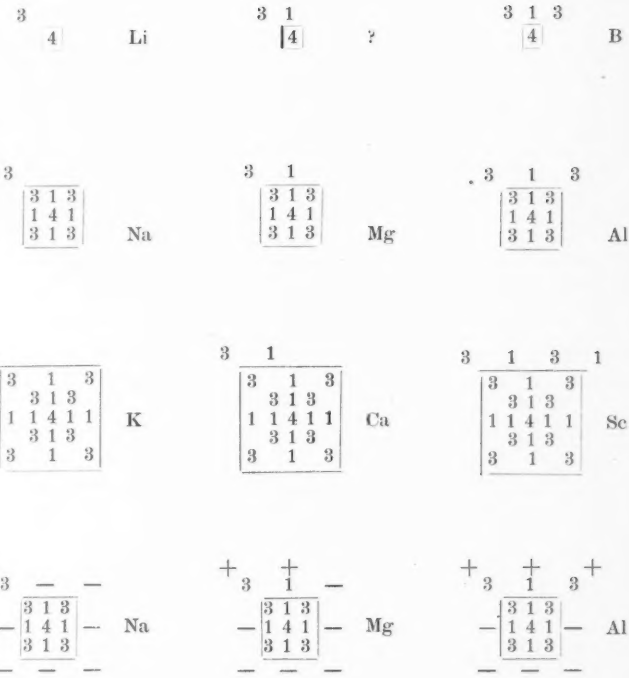
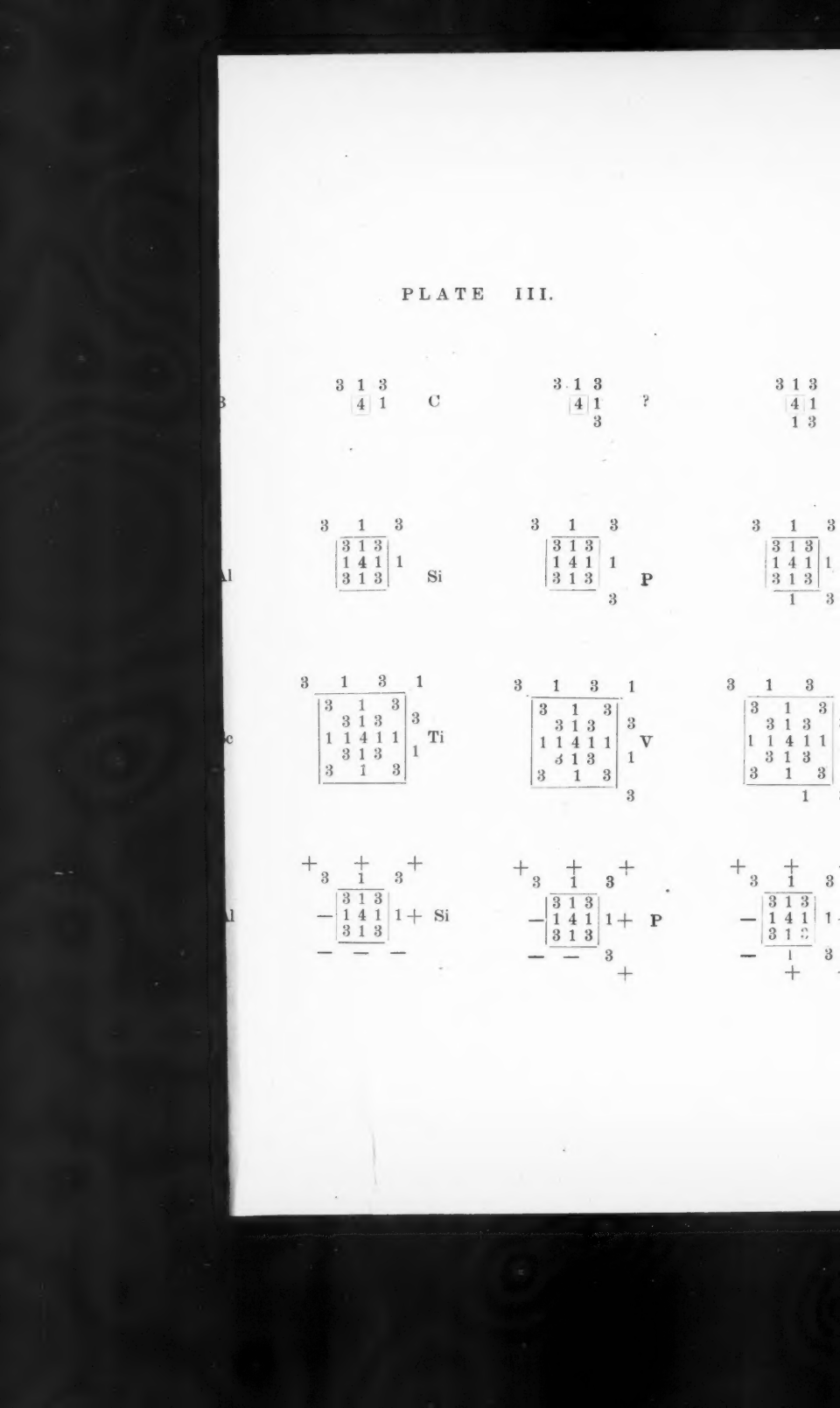

3
4
Li
3 1
4
?
3 1 3
4
B
3
3 1 3
1 4 1
3 1 3
Na
3 1
3 1 3
1 4 1
3 1 3
Mg
3 1 3
3 1 3
1 4 1
3 1 3
Al
3 1 3
3 1 3
1 1 4 1 1
3 1 3
3 1 3
K
3 1
3 1 3
3 1 3
1 1 4 1 1
3 1 3
3 1 3
Ca
3 1 3 1
3 1 3
3 1 3
1 1 4 1 1
3 1 3
3 1 3
Sc
+ 3 − −
3 1 3
1 4 1
3 1 3
− − −
Na
+ 3 + −
3 1 3
1 4 1
3 1 3
− − −
Mg
+ 3 + 3 +
3 1 3
1 4 1
3 1 3
− − −
Al

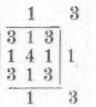
PLATE III.

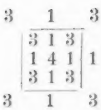

3 1 3
4 1
C
3 1 3
4 1
3
?
3 1 3
4 1
1 3
3 1 3
1 4 1
3 1 3
1
Si
3 1 3
1 4 1
3 1 3
1
3
P
3 1 3
1 4 1
3 1 3
1
1 3
3 1 3
3 1 3
1 1 4 1 1
3 1 3
3 1 3
1
Ti
3 1 3
3 1 3
1 1 4 1 1
3 1 3
3 1 3
1
3
V
3 1 3
3 1 3
1 1 4 1 1
3 1 3
3 1 3
1
+ 3 + 3 +
3 1 3
1 4 1
3 1 3
1 + Si
+ 3 + 3 +
3 1 3
1 4 1
3 1 3
1 + P
3
+
+ 3 + 3 +
3 1 3
1 4 1
3 1 3
1 3

O

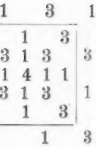
F

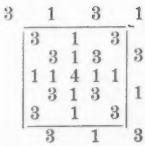
*

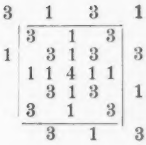

S

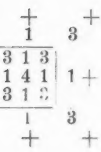

Cl

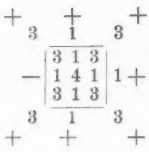
*

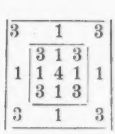

Cr


Mn


Fe


S


Cl


*

Suppose the atom to be composed of a framework with an envelope of ether, and represent the structure upon a plane surface simply for the convenience of illustration.

According to one interpretation of the Perissad Law the atoms of the first group of the first series have been formed from a nucleus of 3 by the addition to it 1, 2, 4, 5, 6, 7, 8, 9, 12, 13 and 14 times of particles having a weight of about 4, and the other groups and series in similar manner.

These increments may have been added to all the extremities up to a certain point and then they may have formed around other points of the atom, or the whole increment may have united to one extremity, the next to another, etc., as shown in Plate II. In the case of elements whose deviations are additive, the excess over the regular increase may be referred to the greater amount of ether associated with the corresponding atoms.

By another interpretation of the Perissad Law of regular increase an artiad atom may have been formed by the addition of 1 to a perissad, then a perissad by the addition of 3 to an artiad, etc., as shown in Plate III. These diagrams suggest answers to the questions, *What is Chemical Affinity, what is Valency?*

Remsen (Theoretical Chem., 1887, p. 287) says of Chemical Affinity:

"We know that when hydrogen and chlorine are brought together they combine with a great evolution of heat. * * * The phenomenon suggests such phenomena of attraction as those of gravitation, electricity and magnetism. We, therefore, picture to ourselves the atoms of hydrogen and chlorine as drawn together by an attractive force, much as the stone thrown upwards is drawn to the earth or as the electrified body is attracted by other bodies. In each case to separate the attracted substances an expenditure of energy is necessary. Without any conception in regard to the nature of this chemical force we may for convenience call it *chemical affinity*. The first object in view in the study of this force is to measure its intensity in different cases. What is the difference between the attraction exerted between hydrogen and chlorine and that exerted by hydrogen and oxygen, etc., etc.? Is it dependent upon the nature of the substance, or is it independent of the nature and only dependent on the mass?"

If the path upon which we have set out proves to be the correct one, it will probably lead to the conclusion that the attractive force is not only similar to but identical with gravitation. The arrangement of the particles in lines increases the intensity more than enough to make up for the small masses as compared with the masses of sensible objects. Atomic repulsion is caused by the kinetic energy or centrifugal force of ether, of which the atoms are composed, and with which they are surrounded; but when they are brought together by external pressure upon the masses or by a loss of heat and diminution of the repulsive forces, the skeletons come within the spheres of their mutual attractions and the union takes place. If the ether is more condensed around the lines forming the skeleton and if it revolves around these lines as axes, the chemical and electrical conduct of the atom may depend upon what part of the skeleton projects so far as to influence the neighboring atoms.

Valency may be described as follows: If we refer the repulsive force produced by the motion of the ether to equipotential surfaces, we may say that a monad atom has one point projecting beyond one of these surfaces, a dyad atom two points, etc. The difference between an electro-positive and electro-negative atom may depend upon the direction in which the ether revolves as suggested by the theory of Ampère or by the fact that one atom exposes a re-entrant to another's salient, as suggested by Table III. Dr. Asche also refers to this combination in a paper on Didymium, read before the British Association in 1889. In the last line of Table III. the electro-positive and negative bonds are expressed by + and — respectively. Much is known and much remains to be known about the position of these bonds in space. The diagram on a plane surface is so generally employed in chemistry that no misapprehension can arise from this form of illustration.

CALCULATION OF BLAST FURNACE SLAGS AS PRACTISED IN CERTAIN WORKS IN EUROPE.

By Auguste J. Rossi, C. E.

In another paper (this journal, Vol. 12, **6, 7**) we have described a practical method of calculating the charges of a blast furnace in order to obtain a slag of a given type, which does not require the use of any formula or chemical symbol. It may be interesting to compare it with the method followed in certain works, in Eastern France, to arrive at the same result.

What is called "a charge" is this certain weight of ore, limestone and fuel, in relative proportion to each other, which are charged in a furnace at regular intervals of time during twenty-four hours. Technically, it is more properly the calculated weights of the relative qualities of limestone and ore necessary to obtain a given composition of slag, the quantity of fuel per ton of iron smelted, or per charge, being, as a rule, a factor which is assumed and which practice has taught, but subject to ulterior corrections as may be required.

The coal is supplied to furnish, by its combustion, the heat and the elements necessary for the chemical reactions which take place and only its ash contributes to the ultimate composition of the slag. In France, the charge is called "*lit de fusion*," an expression, it seems to us, having a more appropriate meaning than the vague term "charge." The total amount of ore and stone constitutes "*a lit de fusion*," "a charge," with an assumed quantity of fuel and the proportion of the two materials, ore and stone, are the elements to be calculated, bearing in mind the character of the slag desired as indicative of a special grade of pig iron and the percentage of ash of the fuel and its composition.

Calculation of a Slag at the Works X.

The formula of the slag expected was that of a "Seisgulo-Silicate" (monosilicate of Percy), $3RO, SiO_3$ or $2RO, SiO_2$ (orthosilicate, bibasic slag); oxygen of acid = oxygen of base.

Two different kinds of ore were used, of which the composition is given below, the calculations being based on the determination of the *free* oxygen in the materials, demand a certain technical knowledge.

1.—Gangue of Ore A.

SiO_3	8.50	Equiv. SiO_3	$=45.3$	Oxygen of SiO_3	$=8.50\times\frac{24}{45.3}=$		4.50
Al_2O_3	5.50	" Al_2O_3	$=51.5$	" Al_2O_3	$=5.50\times\frac{24}{51.5}=$	2.56	
CaO	5.00	" CaO	$=28.$	" CaO	$=5.\times\frac{8}{28}=$	1.43	4.40
MgO	0.90	" MgO	$=20.$	" MgO	$=0.9\times\frac{8}{20}=$	0.31	

2.—Gangue of Ore B.

SiO_3	29.55	on an average	SiO_3; 25.00	O of Acid SiO_3	13.24
CaO	0.15	it was taken	Al_2O_3; 3.50	O of Base Al_2O_3	1.63
Al_2O_3	3.40	to be			
			Free oxygen, acid		11.61

3.—Ash of Coal.

SiO_3	$=47.80$	O of SiO_3		25.32
Al_2O_3	$=33.00$	" Al_2O_3	15.37	
CaO	$=6.00$	" CaO	1.71	18.36
MgO	$=3.20$	" MgO	1.28	
		Free oxygen, acid		6.96

4.—Limestone.

SiO_3	$=2.50$	O of SiO_3		1.32
Al_2O_3	$=2.00$	" Al_2O_3	1.10	16.10
CaO	$=52.50$	" CaO	15.00	
		Free oxygen, basic		14.78

Resume.

Free O, acid, in ore A	0.20
" " " B	11.61
" " in ash of Coke	6.96
" O, basic, in limestone	14.78

Assume 360 kilos. of good coke at 10% of ash, a quantity judged sufficient for "a charge" or "*lit de fusion*," taken to be = 880 kilos. stone and ore. This gives 36 kilos. of ash corresponding to

$$36 \times \frac{6.96}{100} = 2.50 \text{ free oxygen of acid in the ash.}$$

Let m be the weight of ore A to be used, in kilogrammes.

" f " " " B " "

" c " " of limestone " "

Then: The total free oxygen acid = 0.20 m + 11.61 f + 2.50.

Total free oxygen, basic = 14.78 c, and since we want to obtain a bibasic slag, that is one in which oxygen, acid = oxygen, basic.

0.20 m + 11.61 f + 2.50 = 14.78 c, but we have also the equation of condition, total charge: $\underbrace{f + m}_{\text{Ore.}} + \underbrace{c}_{\text{Stone.}} = 880$; we have then two equations containing three unknown quantities. Eliminating c between the two we come to the final equation:

14.98 m + 26.39 f = 13003.90, an equation which is indeterminate, as it should be, since the proportions of ore A and ore B, within the above limits, are evidently optional. Assuming for m certain values we find:

m = 50	f = 464.50	c = 365.50
m = 100	f = 436.00	c = 344.00
m = 200	f = 379.25	c = 300.75
m = 300	f = 322.45	c = 257.55

and the charges will be:

Ore A	50.	514.50 kilos.	Or such others based on the other values of m, f, c. Coke always = 360 kilos.
Ore B	464.50		
Limestone	365.50	"	
Coke	360.00	"	

The ores had about 35% metallic iron, hence 514.50 kilos. of ore would yield 514.50 × 0.35 = 180, iron, and taking the first solution, the relative proportions of the different materials in one charge for one of iron must be:

Ore	2.85	for m = 50.
Stone	2.03	
Coke	2.00	

Adopting the first solution let us calculate the composition of the slag and verify its bibasic character.

	Ore A=50 Kgs.	Ore B=464.50.	Coke=(Ash 10%)36.00 Kgs.	Stone=365.50.	Totals in Slag.
Silica	$\frac{8.50}{100}\times 50=24.5$	$\frac{25.00}{100}\times 464.50=116.12$	$\frac{49.80}{100}\times 36=17.90$	$\frac{2.50}{100}\times 365.50=$ 9.13	146.70 Kgs.
Alumina	$\frac{5.50}{100}\times 50=2.75$	$\frac{3.50}{100}\times 464.50=$ 16.26	$\frac{33.00}{100}\times 36=11.88$	$\frac{2.00}{100}\times 365.50=$ 7.31	38.20 "
Lime	$\frac{5.00}{100}\times 50=2.5$		$\frac{6.00}{100}\times 36=$ 2.16	$\frac{52.50}{100}\times 365.50=191.89$	196.55 "
Magnesia	$\frac{0.90}{100}\times 50=0.45$		$\frac{3.30}{100}\times 36=$ 1.15		1.60 "
Totals	9.95	132.38	32.39	208.33	383.05

Reducing to lime:

Silica $=146.70$

$Al_2O_3 = 38.20\times 1.631 = 62.27$ CaO

CaO $=196.55$ CaO

MgO $=1.60\times 1.40 = 2.24$

146.70 Silica.

261.06 Lime.

407.76

Reducing to a percentage, we find:

$SiO_2 = 35.90$

CaO $= 64.10$

100.00

The type, exactly bibasic, has the composition $\begin{cases} SiO_2 = 34.88 \\ CaO = 65.12 \end{cases}$

The slag is practically a bibasic slag, as closely as possible using two decimals or only one, as in the analyses.

Let us calculate this same slag by the method of reduction to *lime*, adopting the same data and two indeterminate quantities of the ores A and B.

Ore A:

SiO_2	=8.50	8.50	
Al_2O_3	=5.50×1.63=8.95		
CaO	=5.00×1. =5.00	CaO 15.21	
MgO	=0.90×1.49=1.26		

The saturation for a bibasic slag is 0.538 SiO_2 for 1 lime. 15.21 lime will take then: 15.21×0.53=8.18 SiO_2, leaving 0.32 to 0.33% free silica to be saturated for 1 of ore.

Ore B:

SiO_2	=25.00	25.00
Al_2O_3	= 3.50×1.63 ..	2.71 CaO

5.71 CaO will saturate 3.07 SiO_2, leaving 21.93% free silica for 1 of ore.

Ash of Coke (10%×360=36 Kilos.)

SiO_2 47.80		=47.80	
Al_2O_3	=33. ×1.63+	=53.79	
CaO	= 6.	= 6.00	64.27 CaO
MgO	= 3.20×1.40	= 4.48	

64.27 CaO will saturate 64.27×0.538=34.58 silica, leaving in ash 13.22% free silica. For 36 ash $\frac{13.22}{100}\times 36$=4.76 free silica.

Stone:

Silica	=2.50	2.50	
Al_2O_3	=2.00×1.63+ 3.26		
CaO	=	52.50	55.76

1 silica takes up 1.858 lime to make a basic slag. Hence: 2.50 silica will take 2.50×1.858 lime=4.65 lime, leaving as free lime in the stone 51.11%.

Let m be the amount of ore A taken as before, f that of ore B, c that of stone. We have then:

Free Silica in Ore A.....m × 0.33
" " in ash of Coal.....c × 4.76
" " in Ore B.....f × 21.93

Total free *silica* in ores and coal: 0.33 m + 21.93 f + 4.76

Total free *lime* in stone: 51.11 c

and since the free lime of the stone must saturate the free silica of the ores, stone and ash, at the rate of 0.538 silica for 1 of lime the 51.11 c of free lime in stone will take up 51.11×0.538 c = 27.50 c of *silica*. We have then this equation free silica to saturate 0.33 m + 21.93 f + 4.76 = 27.50 c silica saturated by stone. All the terms being expressed in *silica*, SiO_2, if we multiply them *all* by $\frac{8}{15}$, which does not change the equation, we shall have the relation of equality of the oxygen found previously by the other method as near as the difference of the numbers expressing the equivalents of silica formerly, and now (taking only one or two places of decimals) we have the differences appearing only in hundredths as already observed. 0.18 m + 11.68 f + 2.15 = 14.66 c, instead of 0.20 m + 11.61 f + 2.50 = 14.78 c. We have a second equation of condition the same as in the first method: f + m + c = 880. By combining these two equations and taking m = 50, 100, etc., we shall find the same figures as already calculated or differing only in hundredths.

THE AERATION AND COMPOSITION OF NIAGARA RIVER WATER ABOVE AND BELOW NIAGARA FALLS.

By Dr. Albert R. Leeds.

The great height of Niagara Falls and the churning up of its waters at the base with the large volumes of air mechanically carried down into the deep basin below the Falls appeared to afford a good opportunity of examining into the question of the aeration so produced, and the chemical changes, if any, resultant therefrom.

With these objects in view, and with the assistance of Dr. F. P. Vandenbergh, the City Chemist of Buffalo, I collected duplicate samples of the water both below and above the Falls. The former were taken on the American side at a point so near the Falls that we were well wet with the spray during the short interval required to secure the samples; the latter were collected at the upper end of Goat Island. The collection was made July 9th, 1890.

The dissolved gases were as follows:

IN ONE LITRE: VOLUMES STATED IN CUBIC CENTIMETERS.

	Above the Falls.			Below the Falls.		
	(1)	(2)	Mean.	(1)	(2)	Mean.
Carbon Dioxide	0.96	0.79	0.875	0.89	0.84	0.865
Oxygen	4.93	5.22	5.075	5.02	5.29	5.155
Nitrogen	11.94	13.00	12.47	12.12	13.05	12.58
Total Gases	17.83	19.01	18.42	18.03	19.18	18.605

On making a comparison of the mean results, it would appear that the sum total of the air in the water collected below the Falls is 0.185 cubic centimetre per liter greater than in the water above; the oxygen is 0.08 c. c. more, and the nitrogen is 0.11 c. c.

greater. The ratio of the dissolved nitrogen to the dissolved oxygen in both sets of samples is nearly 72.3 to 27.7 This is a low ratio for the oxygen, and is to be considered in relation to the character of the Niagara River water, which has a yellow color, due to a considerable amount of peaty extractive matter.

The three constituents which it was thought might have experienced sufficient change as to admit of the detection of the alteration by chemical analysis were the ammonia, the albuminoid ammonia and the organic matter as measured by the oxygen required to effect its oxidation. The results were as follows :

IN PARTS PER 100,000.

	Above the Falls.			Below the Falls.		
	(1)	(2)	Mean.	(1)	(2)	Mean.
Ammonia	Lost.	0.0056	----	0.0058	0.006	0.0 59
Albuminoid ammonia	0.0114	0.0106	0.011	0.0108	0.011	0.0109
Required oxygen	----	0.226	----	----	0.226	----

It would not answer to draw any inferences from these figures as to a change of composition due to the contact with a slight increase of dissolved oxygen during three or four seconds' interval. Samples taken below the Whirlpool, which is some distance below the Falls, might exhibit quite a different result.

COMPOSITION OF SWILL MILK.

By Dr. Albert R. Leeds.

The Dairy Commissioner of the State of New Jersey, under the impression that the milk supplied by cattle entirely stall-fed upon the swill and brewery grain obtained from New York hotels and breweries would afford milk of quality below the State standard, and objectionable or dangerous on other accounts, has recently submitted a sample of this milk to me for examination. The cattle were in dark, dirty and ill ventilated stables, the principal alleviation of their condition being that afforded by a great abundance of excellent spring water for drinking. At the time of collecting the sample, which represents the milk of a number of cows, the animals appeared to be all in good physical condition.

The milk was normal in color, smell and taste, with slightly acid reaction. Its specific gravity at 15° C. was 1.0309.

Instead of giving very low percentages, all its constituents were as high in amount as is usual in the milk obtained at the same season of the year (November) from dairy cattle. The composition was :

Albuminoids	3.469 per cent.
Fats	5.17 " "
Lactose	4.427 " "
Ash	0.749 " "
Total	13.815

A plate culture of from one drop, one-twentieth of a cubic centimeter, showed the presence of 4,200 colonies of bacteria after the lapse of eighteen hours, with so numerous a proportion of liquefying colonies that further counting was discontinued.

The swill fed to these cattle was accompanied by a large amount of brewers' grains, the latter indeed being the chief component of the food. There was no hay, or other feed, nor were they at any time put on pasturage.

A NOTE ON ALUM PHOSPHATE BAKING POWDERS.

By Lucius Pitkin, Ph. B.

The point of view from which healthfulness or unhealthfulness has been predicated for the combinations usually employed as leavening agents has been shifted considerably during the last few years. The main contention has been, and continues to be, in regard to the advisability of alumina compounds in such food products, but the positions assumed by both advocates and opponents have been not only modified, but on some points reversed.

It will be conceded, we think, that much of adverse opinion in regard to the employment of burnt alum in baking powders has arisen from confusion concerning two very distinct purposes for which alum has been used.

Its peculiar action upon flour producing a whiter and lighter bread from inferior and in some cases unsalable flour than could otherwise be obtained, early led to its adoption in England and on the Continent, for the purpose of enhancing the value of bread products beyond their legitimate value. It was thus a fraud upon the consumer, calling for and being met by legislative restriction; nor should it be forgotten that the alum was added to the bread as crystallized alum possessing, when in the bread, all the properties of that salt, and being extracted therefrom in large proportion by water.

In the use of alum in baking powder the conditions are entirely changed; the powder being used by the buyer, the purpose for which legislative interference was first invoked is no longer a factor and from a sanitary point of view the question is no longer

centered on alum as such, but on hydrate and phosphate of alumina.

In the celebrated Norfolk baking powder case (*Analyst* **4**, *page 231*) it was contended that the phosphate of alumina was entirely insoluble in the human system, that thus the flour was deprived of its phosphatic constituents by the alumina in the powder forming insoluble residues, and on that account alum baking powders should be condemned. With the advent of acid phosphate of lime as used in combination with burnt alum for liberating the carbonic acid of sodium bicarbonate such objections were forestalled, since much more phosphoric acid was introduced than could possibly be removed from the flour.

The reversal of opinion to which we alluded was now taking place and statements and calculations made were based upon the assumption that all of the alumina left in the residues of bread and biscuit was taken up in the system, whereas it had been claimed before that they were insoluble.

Direct experimentation made on a typical phosphate and alum composition seemed, however, to be at variance with such assumptions since in the nearest approach possible to the actual conditions the factor arrived at for the solubility of residues from phosphate and alum powders in the mouth and stomach was found to be $\frac{1}{5}$ to $\frac{1}{6}$ of the alumina present (*Pitkin, Journal American Chem. Soc.* **9**, *p. 27*).

The consideration of the effect of the residues from the various powders upon digestion now began to be taken up, and much attention was bestowed upon that aspect of the question in the various State Boards of Health and Government reports. Some comparative figures on the action of the various combinations have been published (*Pitkin, Journal Am. Chemical Soc.*, Vol. 12, 8) which seem to indicate that, in albuminoid digestion at least, there is little difference between the action of residues from cream of tartar and alum phosphate powders, while sour milk and soda also seems to exercise an almost identical inhibitory action. The basis upon which these results were obtained was a comparison of residues from neutralization of the same quantities of sodium bicarbonate—in other words, equal leavening equivalents of the residues were employed.

In glancing over a late Government Report (Food and Food Adulterants, Part 5th, Bulletin No. 13, p. 575) we find the following table:

Powders.	Carbonic Acid Gas. Per cent.	Total residue of the weight of Chemicals used. Per cent.
Tartrate	16.	104
Phosphate	22.	123
Alum	27.	128
Alum and Phosphate	17.	111

As will be seen at a glance the alum and the phosphate powders give the least residue per unit of gas evolved, while the alum and phosphate combination is credited with the greatest percentage of residue to carbonic acid. When it is remembered that it is upon the amount as well as upon the character of residues that attention is now specially directed, it is obvious that the ratio is a matter of no little importance.

One would naturally suppose that such a combination powder would be somewhat intermediate in its leavening action between the two classes to which it is related.

Looking over the report to see upon what data the figures quoted were obtained we find, p. 571:

"A case in which the character of the powder appears to be improved by such mixing, however, is furnished by the alum and phosphate powders.

This combination seems to be a favorite one with manufacturers. In fact there are now comparatively few "straight" alum powders in the market, most of the cheaper grades being made of mixtures in various proportions of the alum with acid phosphate of lime, the reaction it is intended to obtain is probably the following:

$$\underset{\text{Ammonia alum.}}{\overset{475}{(NH_4)_2\,Al_2(SO_4)_4}} + \underset{\text{Acid phosphate of lime.}}{\overset{234}{CaH_4(PO_4)_2}} + \underset{\text{Bicarbonate of soda.}}{\overset{336}{4NaHCO_3}} = \underset{\text{Phosphate of aluminium.}}{\overset{245}{Al_2(PO_4)_2}} +$$

$$\underset{\text{Sulphate of lime.}}{\overset{136}{CaSO_4}} + \underset{\text{Sulphate of aluminium.}}{\overset{132}{(NH_4)_2SO_4}} + \underset{\text{Sulphate of soda.}}{\overset{284}{2Na_2SO_4}} + \underset{\text{Carbonic-dioxide.}}{\overset{176}{4CO_2}} + \underset{\text{Water.}}{\overset{72}{4H_2O}}$$

On page 567 in discussing phosphate powders, 234 parts of $CaH_4(PO_4)_2$ is credited with the power of liberating 88 parts of carbon dioxide: on page 569, 475 parts of $(NH_4)_2 Al_2 (SO_4)_4$ liberates 264 parts of carbon dioxide, but by the equation used in discussing alum phosphate powders only half enough sodium bicarbonate is given to the above quantities of "acid phosphate" and burnt alum to liberate the 88+264 parts of carbon dioxide which they would separately set free.

We think the published analyses in the report conclusively prove that while the combination may be "a favorite one with manufacturers," they certainly do not intend to obtain the reaction with which they are credited. No such ratio is found to exist between the ingredients in a single one of the fifteen complete analyses of alum phosphate powders printed in the bulletin.

All baking powders lose more or less carbonic acid on keeping, depending upon the amount of moisture absorbed, quantity of "filler" present, length of time elapsing since manufacture, etc. It will therefore be advisable to examine the ratios between, for instance, the sulphuric anhydride and sodium oxide (both being proportionally increased by any loss in carbonic acid gas) called for by the formula and that found in actual analysis.

By the formula $(SO_3)_4$ corresponds to 4 Na or 2 Na_2O by weight 320 parts of sulphuric anhydride should be found for each 124 parts of sodium oxide or the ratio of SO_3 to Na_2O should be more than 2.5 to 1.

In the analyses we find:

No. 5510	So_3 = 9.79%	Na_2O = 12.25%
" 5511	" = 11.02%	" = 12.58%
" 5512	" = 11.57%	" = 14.04%
" 5515	" = 13.01%	" = 9.83%
" 5516	" = 12.26%	" = 9.21%
" 5517	" = 13.18%	" = 8.33%
" 5519	" = 8.78%	" = 7.26%
" 5520	" = 10.51%	" = 11.92%
" 5521	" = 11.54%	" = 11.20%
" 5524	" = 10.14%	" = 10.87%
" 5525	" = 8.93%	" = 12.15%

No. 5530	"	= 10.57%	Na_2O	= 10.32%
" 5532	"	= 11.30%	"	= 11.36%
" 5533	"	= 10.66%	"	= 12.69%
" 5534	"	= 13.23%	"	= 12.29%

By averaging the above it will be seen that the percentages of sodium oxide and sulphuric anhydride are practically equal, instead of corresponding to the ratio demanded by the formula, nor is ratio of phosphoric acid to sodium oxide much closer to what is demanded. There is evidently a mistaken assumption therefore upon which the high ratio of residue to leavening power has been asserted of this class of powders, and the influence attaching to such an exhaustive report from such a source forms a sufficient excuse, I trust, for calling attention to the error.

NOTES UPON WATER ANALYSES BY THE AMMONIA METHOD WITH SOME NEW APPARATUS.*

BY A. A. BRENEMAN.

Wanklyn's ammonia method of water analysis, in spite of its imperfections, is still the process most widely used in this country. It is the simplest and most practicable of all combustion methods, wet or dry, that have been applied to water analysis, and although it shares with all processes of this class used in sanitary work, the doubt as to interpretation of its results, its general use among chemists indicates its superior adaptability to such work.

The process as now used is essentially the original one, but experience has shown that the interpretation of results must be guided by familiarity with the method and by a knowledge of the class to which the water in question belongs. Also, there is now a marked tendency to prescribe more closely than Wanklyn has done the minute details of the process.

The variability of natural water with respect to the indications which they yield under Wanklyn's process, as to time of distillation, concentration of reagents and rate of attack of oxidable matter, have necessitated the adoption of standard methods as the nearest approach to a means by which the results obtained from different waters, and by different observers, could be made in any sense comparable.

I have shown in a previous paper (*This Journal, Vol. 8, No. 9*) the points in which such prescription of detail should be insisted upon and have suggested a standard method for general use. The previous work of Mallet, Smart, and others, had suggested many similar points of detail requiring attention.

The Report of the Committee of the Chemical Section of the American Association for the Advancement of Science for 1889

*Read at the Newport Meeting.

upon the methods of water analysis adopts many of these different suggestions. With regard to the quantity of water to be used the quantity is left optional, as to 500 or 100 c.c., in this report. In common with many other chemists I should have been glad to see a recommendation as to the exclusive use of the 100 c.c. method and of 10 c.c. nesslerizing tubes as representing a neater and more accurate method of conducting the analysis. The use of the smaller quantity of water is no exception to the general preference in chemical analysis for small samples where accuracy is not impaired by their use. In the present case there are to be offered the advantages of less cumbrous apparatus, a hastening of the process and an increase in accuracy by the use of the smaller tubes with their greater depth for a given volume of the liquid submitted to the colorimetric test.

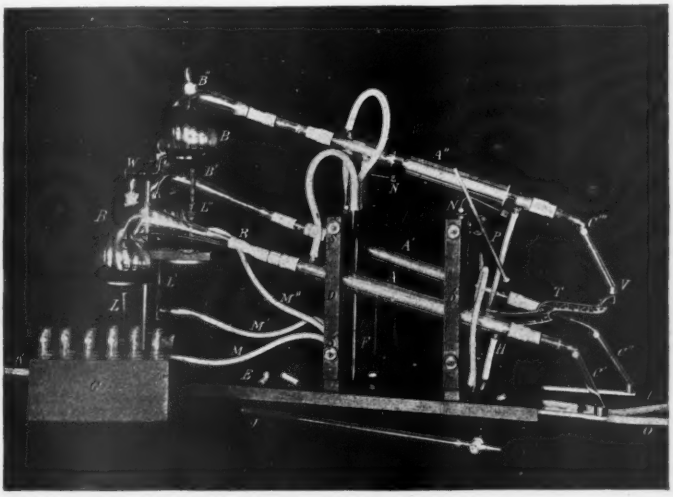
Another detail upon which I have insisted, as necessary in order to render results obtained by the Wanklyn process comparable, as nearly as possible, for waters of all classes, is the matter of carrying the distillation to a very small residual volume in the retort, so that the greatest strength of the permanganate and alkali and the strongest attack upon oxidable matter shall be concentrated upon the organic matter which has longest resisted that attack; in other words the carrying of the distillation to a point near dryness. This again is much more easily done in a small than in a large retort, for obvious reasons. Further, the accurate measurement of all liquids put into the retort permits a control of the distillation by measurement of the 10 c.c. portions which are taken off as distillates during the operation, or of the 85 c.c. portion taken off in the preliminary process of cleansing the retort as already described. (*loc. cit.*) The degree of condensation may thus be judged of and the volume of the residual liquid in the retort at the close of the operation may be known within 2–3 c.c. at most. In practice I leave less than 5 c.c. of liquid in the retort at the close, yet accidents from running dry or spurting are almost unknown.

The objection that modification of the old method will prevent comparison of the results with those previously obtained, is an objection that, in some sense, meets every attempt at improvement of an analytical process and cannot be regarded as insuperable.

In the present case, the difference under the prescribed conditions is not such as to cause confusion, while the gain in comparability of all results obtained by the modified method among themselves, as compared with the same comparability under the old method, is of the greatest importance.

In connection with the foregoing I present a holder for retorts and condensers which has been used in its present form for water analysis during about four years and has been found very convenient.

It permits simultaneous examination of three samples of water, while the entire apparatus in operation can be lifted or moved without injury to any of its parts. The latter consideration relates to the prevention of accidents which sometimes occur from slight movements of pieces of glass apparatus rigidly connected but resting upon different bases, and its advantage will be readily understood. The management of these retorts and their distillates is just sufficient to keep one person steadily occupied ; with one or even two retorts there is much waiting time with the consequent temptation to neglect the apparatus temporarily for other work.



The cut will be readily understood.

The condensers are held between cork-faced jaws D, D′, by clamp screws S, S′. Water for cooling enters by the rubber tube I and escapes through O. Gas enters by K. and is distributed by a tube forked above the base to connect with the rubber tubes M, M′, M″. The water tubes H and F are similarly forked above the base. The nessler tubes C′, C″ rest in sockets which slide, by square brass rods, into deep holes in the base through a brass plate on the edge of the base, and are very steady and smooth in motion. The japanned bracket supporting C‴ swings sidewise but can be fixed by a single motion, rigidly in the position shown. The upper retort B″ can be lifted off, with its condenser, as it rests only in vertical holes upon the shanks of the clamps N, N′; the inclination of the condenser, however, is controlled by two small set-screw collars on the shanks.

As auxiliary apparatus we may mention the tube block, C, having tapering holes, wide at the top and made of wood first stained and then saturated throughout with paraffin which is, lastly, well rubbed in. It is very firm and convenient for rapid handling of the nessler tubes.

The stirring pipette, P, has a beaded end and a short, wide tip below the bead. It is held in an ordinary spiral pen rack fastened to the stand. The caps E, of rubber tube and glass rod are used to close the condenser tubes when not in use; much time is thereby saved in freeing the retort from ammonia. The burette J, graduated to 0.5 c.c. is used for measuring nessler solution of which 0.5 c.c. is used for each 10 c.c. of distillute.

SYNTHESES IN THE SUGAR GROUP.

By Emil Fischer.

(*Concluded.*)

Translated by L. H. Friedburg, Ph. D.

Analysis and synthesis meet at this point, since i-mannite is identical with synthetical α-acrite, and it was an easy matter to prove that α-acrose, regenerated from the osazone is nothing else than i. fructose.[1] In order to conclude the synthesis of natural sugars it remains only to search for the transition of the middle inactive series into the side series.

The fundamental work of *Pasteur* taught us two methods for the transformation of inactive substances into optically active ones: partial fermentation by bacilli, or splitting by crystallization of the salts. With sugars, only the first way is applicable. Here, yeast is to be preferred to mold ferments and splitting ferments as used by Pasteur and others. An aqueous solution of synthetical α-acrose ferments actively in a short time with beer yeast. In one to two days the fermentation is completed. The liquid, previously inactive, then rotates strongly to the right and furnishes a d-glucosazone, since the yeast left behind in it the *laevo-fructose.*[2] It may seem surprising, that a sugar of strongly dextro-rotary power is enumerated here as a laevo compound. But the signs d. and l. are not intended to express in every case the power of rotation, which changes without regularity, but rather the *chemical* nexus of these compounds. The letter d. has been chosen for the group of natural sugars because most of them turn towards the right. But in consequence it has also to be maintained for fruit sugar, which, in spite of its power of rotation to the left, belongs to the same geometrical series as the d-mannose.

[1] *Ber. d. chem. Ges.*, **23**, *384* and *387*.
[2] *Ber. d. chem. Ges.*, **23**, *389*.

The action of beer yeast upon i-mannose is quite analogous, the dextro part ferments and l-mannose remains behind.[3]

In both cases the yeast uses up that part of the inactive substance to which it clings by force of past evolution.

But this method only leads to the less interesting sugars of the l series. In order to obtain the natural products of the d series synthetically, chemical methods are required, which lead on to the end by the following reactions.[4]

Careful oxidation of i-mannite with nitric acid furnishes i-mannose which by means of bromine water is transformed into i-mannonic acid. This latter is split by means of the strychnia—or morphia—salt into d- and l-mannonic acids, from which result by reduction, the optically active mannoses and mannites. Then the way leads from d-mannose and its glucosazone to d-fructose.

In the mannite series there remains now only the synthesis of glucose and its derivatives and isomeres, which have been enumerated in the glucose group of the table above. We mentioned that glucose is stereo-isomeric with mannose. [The older assumption of glucose as the aldehyde of mannite was proved to be erroneous by the discovery of mannose. But I have furthermore convinced myself of this fact by a new research of the reduction of grape sugar by sodium amalgam. Working in the old way, allowing the sugar solution to remain over the amalgam, the operation lasts for weeks and then really furnishes mannite, however in a quantity proportionally small. But if the detrimental action of the alkali is prevented by frequent neutralization with sulphuric acid, and if by continuous agitation the action of the amalgam is accelerated, the reaction is accomplished as swiftly as with mannose and other aldehydic sugars. Using quantities of 10 grms., twelve to fifteen hours finish it; no mannite is then obtained, at least its quantity is so trifling that I was unable to isolate it. Instead, a syrup results which is easily soluble in alcohol and which most likely contains a hexatomic alcohol, stereo-isomeric with mannite. (Compare also, C. Scheibler, *Ber. d. chem. Ges.*, **16**, *3010.*)]

Glucose and mannose both furnish an identical glucosazone and

[3] *Ber. d. chem. Ges*, **23**, *382.*
[4] *Ber. d. chem. Ges.*, **23**, *389.*

consequently the isomery between the two depends upon asymmetry of that [5]carbon atom marked * in the following formula:

$CH_2(OH).\ CH(OH).\ CH(OH).\ CH(OH).\ *CH(OH).\ COH.$

Thus it might be expected that a reciprocal transformation of the two compounds was feasible. These easily decomposed sugars, however, do not admit of the experiment. The pertaining acids do, however, by heating them with quinoline.[6]

I chose this tertiary basis because it cannot form amido-like compounds, and because it is so easy to remove it again from the mixture of reaction.

Gluconic acid heated with quinoline to 140°C. is partly transformed into mannonic acid; conversely this latter, under similar conditions, yields a considerable quantity of gluconic acid. These observations recall the known reciprocal conversion of racemic acid and mesotartaric acid.

Now, since gluconic acid is transformed by nascent hydrogen into glucose, the total synthesis of this latter is realized.

Exactly the same process leads from l-mannonic acid to the compounds optically isomeric with gluconic acid and grape sugar. They are enumerated in the above table as l-gluconic acid and l-glucose. The preparation of l-gluconic acid from l-mannonic acid by heating with quinoline signifies its synthesis, but this procedure is so circumstantial and yields so little that the acid would perhaps not have been found, unless it had been met with and studied on another path. Curious to say this l-gluconic acid forms abundantly from arabinose by aggregation of hydrocyanic acid. Along with it is formed arabinose carboacid, isolated by Kiliani. The simultaneous formation of two stereoisomeric products on addition of hydrocyanic acid to aldehydes, which here was observed for the first time, is very remarkable, theoretically as well as practically. According to expectation l-gluconic acid is deceptively similar to the d-compound and both acids unite in aqueous solution to a third inactive substance which forms independent salts as well as other inactive derivatives.

---

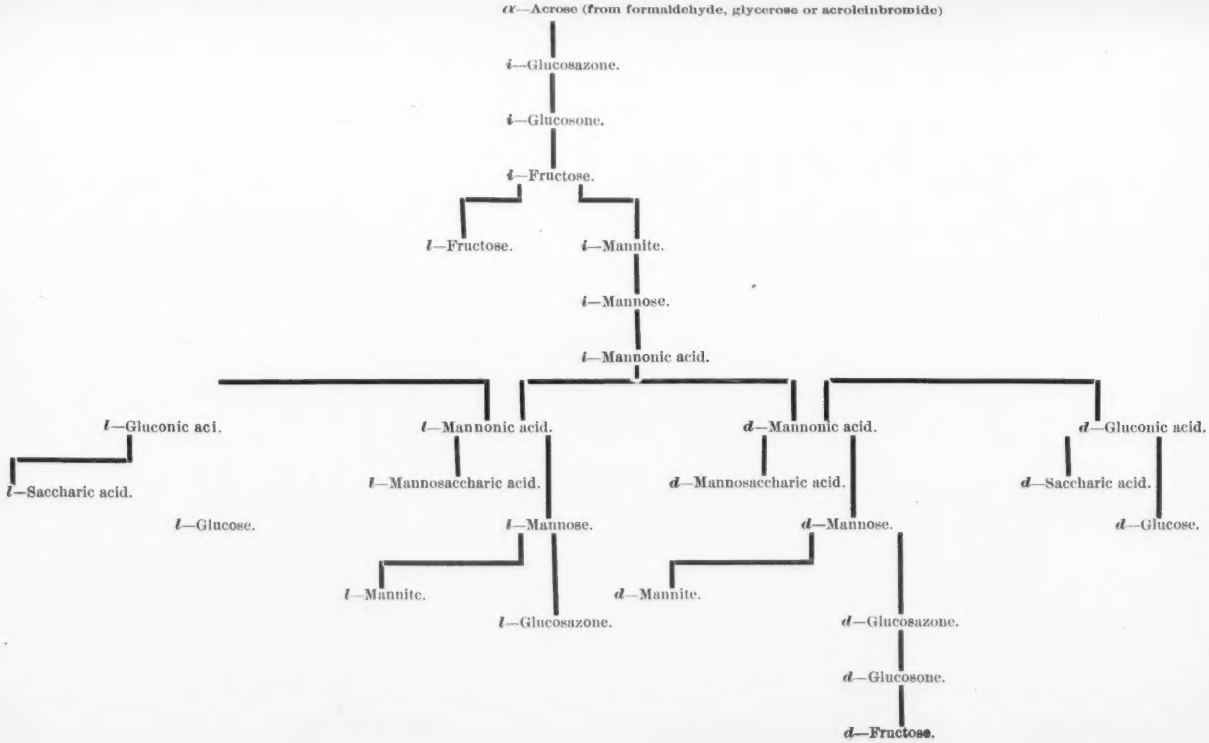
[5] *Ber. d. chem. Ges.*, **22**, *374*.
[6] *Ber. d. chem. Ges.*, **23**, *799*.

From l- and i-gluconic acids we obtain by reduction the optical isomeres of glucose (enumerated in the above table as l- and i-glucose) ; by oxidation l- and i-saccharic acids are formed.

Leaving the nitrogenized products aside, we now know no less than 26 bodies of the mannite series which may be subdivided into the fructose, mannose and glucose groups.

One might feel tempted to use this rich material as a touch-stone for the consequences of Le Bel-van't Hoff theory. Let it suffice to say that all compounds fit into the general frame of this theory, but that, most likely, our views in regard to the union of isomeric substances with asymmetric carbon atoms has to be modified.

All members of the mannite series are joined by transitions, all of them are to be obtained by direct synthesis. The following table gives a systematic view of this latter, beginning with *a*-acrose.


α—Acrose (from formaldehyde, glycerose or acroleinbromide)
i—Glucosazone.
i—Glucosone.
i—Fructose.
l—Fructose.
i—Mannite.
i—Mannose.
i—Mannonic acid.
l—Gluconic aci.
l—Saccharic acid.
l—Glucose.
l—Mannonic acid.
l—Mannosaccharic acid.
l—Mannose.
l—Mannite.
l—Glucosazone.
d—Mannonic acid.
d—Mannosaccharic acid.
d—Mannose.
d—Mannite.
d—Glucosazone.
d—Glucosone.
d—Fructose.
d—Gluconic acid.
d—Saccharic acid.
d—Glucose.

Thus we are now enabled, starting from one of the simplest of carbon compounds, formaldehyde, to prepare the two most important natural sugars.

But upon the basis thus gained the synthesis leads further on to sugars containing a greater number of carbon atoms. Any one of the previously mentioned "oses" can be transformed into an acid, richer in one carbon atom, by aggregation of hydrocyanic acid. The lactone of any such acid, when treated with sodium amalgam, will be reduced to a corresponding sugar, and starting from this latter, the modus of building up a higher compound can be repeated in a similar manner.

In this way Passmore and myself have obtained from mannose a compound $C_9H_{18}O_9$, and thus far we are unable to see the limit of this mode of procedure.

The older nomenclature is not sufficing for the denotation of these numerous synthetical products. I have therefore proposed a new one[7], which temporarily meets the want.

The sugar is named according to the number of carbon atoms which it contains: Triose, tetrose, pentose, hexose, heptose, octose, nonose and the different isomeric products receive a prefix, indicating their derivation. This nomenclature seems to collide with[8] Scheibler's proposal to call sugars: $C_{12}H_{22}O_{11}$ (the so called saccharoses) bioses, and sugars: $C_{18}H_{32}O_{16}$ trioses. In reality the two proposals are easily combined in forming the words, hexobiose and hexotriose. For the general distinction of aldehyde and ketone sugars, Armstrong's names, aldose and ketose, seem well fitted.

The greatest hindrance to suitable names for the now known optically isomeric sugars is offered by the words heretofore in use, laevulose and dextrose. It will be good to drop them altogether in spite of the famous authorship of Berthelot and Kekulé. Instead of dextrose, the old name glucose may be used, and for laevulose I have used above the non-ambiguous name fructose, to which Liebermann drew my attention.

---

[7] *Ber. d. chem. Ges.*, **23**, *934*.
[8] *Ber. d. chem. Ges.*, **18**, *646*.

The preferences of the new nomenclature are very obvious in the following table, which contains all now known simple sugars:

Trioses: Glycerose (mixture of glycerolaldehyde and dioxyacetone).

Tetroses: Erythrose (most likely a mixture of aldose and ketose).

Pentoses: Arabinose (aldose).
Xylose.
Methylpentose: Rhamnose (aldose).

Hexoses: d-l-i. Glucose, d-l-i. Mannose (aldoses), d-l-i. Fructose (ketose) — Mannite series.
Galactose (aldose of dulcite series).
Sorbinose.
Formose, β-acrose (unknown constitution).
Methylhexose: Rhamnohexose (aldose).

Heptoses: Mannoheptose,
Glucoheptose,
Galaheptose,
Fructoheptose,
Methylheptose: Rhamnoheptose
Octoses: Mannoctose,
Glucoctose,
Nonoses: Mannononose,
(aldoses).

Glycerose and erythrose have been explicitly dealt with before. Amongst the pentoses we find arabinose and xylose[9]. The first is an aldehyde with normal carbon chain, and belongs to the l- mannose series. The constitution of the second is not yet determined. Rhamnose must be considered as a methylpentose with normal carbon chain.

The number of hexoses we find considerably increased. Grape sugar and fruit sugar are to be seen here as d- glucose and d-fructose; along with them we find their optical isomeres.

Galactose and sorbinose stand as isolated as formerly. Formose and β-acrose are too scantily investigated as to judge about their constitution. It appears unlikely that they should contain a normal carbon chain.

[9] Wheeler and Tollen's *Ann. Chem. Pharm.*, **254**, *304*.

Rhamnohexose (methylhexose) has been prepared synthetically from rhamnose by aggregation of hydrocyanic acid. The same is true for the following heptoses, octoses and nonoses, the origin of which is expressed by the prefixes. Most of these products surpass in their capacity of crystallization, and in beauty the derivatives of natural hexoses.

The most interesting of them is the mannononose, *because it ferments with beer yeast as easily as glucose.* This property is wanting to the octoses, heptoses and pentoses, but we find it existing with most hexoses and with glycerose. Yeast, therefore, seems to incline to the number three and its multiples.

In comparing this table with the one first given, which represented the sugar group of a few years ago (Journ. Am. Chem. Soc., **12**, 340), we recognize the extent of the newly gained territory.

Many of these artificial sugars will certainly be found some day in plants. Indications exist, since the heptatomic alcohol, which is generated from mannoheptose by reduction is identical with *perseit,* occurring in the fruits of *Laurus Persea,* which, according to newer researches of Maquenne[10] has the formula $C_7H_{16}O_7$. But these observations are only of secondary importance; they are a mere by-products of the new methods. The centre of interest is offered by the synthesis of grape sugar and fruit sugar, since it is suited to open the understanding of one of the grandest and most remarkable physiological processes, that of formation of carbohydrates in the green plant. As far as our knowledge reaches, grape and fruit sugar are the first products of assimilation, and they thus form the carbon-bearing material from which the plant prepares all other organic compounds. Up to this day practically nothing is known about the process of natural formation of sugar. All attempts of explanation are mere hypotheses, the value of which may be disputed. If in spite of this, I shall now mention one, this is only done in order to point out the path on which, perhaps, the results of my researches may be utilized for physiological experiments.

According to the view of Baeyer, carbon dioxide is reduced at first within green leaves to formaldehyde. This latter, then,

[10] *Compt. Rend.*, **107**, *583;* and *Ann. Chim. Phys.* [6], **19**, *1.*

by condensation is transformed into sugar. Since heretofore it has not been possible to prove the existence of quantities of formaldehyde notable in some degree in leaves, it may perhaps be more proper to search for other intermediate products, particularly for glycerose, according to the now known methods.

And even of more interest seems this other question : chemical synthesis leads, as we have seen above, starting from formaldehyde, in the first place to optically *inactive* acrose. In contrast to this we have found in plants heretofore exclusively the *active* sugars of the d-mannite series. Are these the only products of assimilation? Is it a prerogative of the living organism to prepare optically active substances. Is here a particular cause active, a sort of vital force? I do not believe it, but incline towards the view that it is merely the imperfection of our knowledge which surrounds this process with the halo of a miracle.

Not one known fact exists, to directly deny that the plant at first prepares *inactive* sugars, just as chemical synthesis does, that then it splits these using the members of the d-mannite series to build up starch, cellulose, inuline, etc., etc., while the optical isomeres serve other purposes, still unknown to us.

This question will soon be answered by a closer study of the sugars occurring in plants, since the methods given facilitate this work greatly.

These considerations have brought us to the territory of limits between chemistry and physiology and thus I will touch another problem, the experimental treatment of which lies nearer to the biologist than to the chemist.

The natural carbohydrates next to the albuminoids are the most important food for the animal, particularly for herbivora, and we possess a great number of valuable observations in regard to the fate of these in the body of the animal.

May it not be possible to replace these natural carbohydrates entirely or partly by some of the artificial sugars and what then would be the consequence?

Mannose, standing so near to grape sugar and so easily fermentable by yeast, will be most likely, even for the higher organized animal a food ; and still this small change of material may cause corresponding changes in physiological processes.

After partaking of mannose will a new glycogen be produced by the liver, will a substitute for milk sugar be formed by the mammary gland, will the system of the diabetic be able to oxidize this sugar?

In offering as a food to the animal body a pentose, heptose or even the easily fermentable nonose, the physiological changes would become still more visible. We would find that the blood and the tissues were modified in their functions, the pig or the goose would produce another fat, the bee another wax.

This experiment should even be carried further.

The assimilating plant builds up from sugar not only the more complicated carbohydrates and the fats, but also with the auxilliary inorganic nitrogen compounds, the albuminoids. The mold and splitting organisms do this likewise.

Now, in nourishing the assimilating plant or those organisms by means of a differently composed sugar, they might be forced to even produce a different albumen. And then should we not expect that the change in building material would have as a consequence a change of architecture? Thus a chemical influence upon the formation of an organism would be gained, which would lead to most peculiar phenomena: to changes of form which would leave behind them everything heretofore attained by breeding and cross breeding.

Since the fundamental work done by Wöhler and Frerichs [11] hundreds of organic compounds have been incorporated into the animal body, in order to trace (often in the most tedious manner) their products of decomposition in the urine. But physiological chemists have used almost exclusively material of not the slightest similarity with natural food.

A wide field of work is opened to them in the use of these new sugars, the results of such work promises, by far, more remarkable results.

Biology stands here before a question which, as far as I know, was never put before and could not very well be put, since chemistry had not furnished the material for the experiment.

The question is worthy of the experimental test.

---

[11] *Ann. Chem.* (*Liebig*), **65**, *335*.

For the chemist proper enough work remains to be done with the carbohydrates. The mannite group, it is true, is completely built up as few other chapters of organic chemistry are, but in the dulcite series the old state of affairs prevails.

Supposing this group should in the very nearest time be opened as perfectly as its isomeric group, we would, nevertheless, know only eight hexoses of the structure of grape sugar, not counting the inactive compounds which allow of splitting.

But modern theory anticipates no less than sixteen, and it is very likely, according to experience in the mannite series, that they are all able to exist.

It is even not too much to foretell that the preparation, according to the methods described, will not be over difficult, as soon as it is possible to transform the different tartaric acids into the optically isomeric trioxybutyric acids.

A problem of a different nature is put to synthesis by the example of the plant, which, starting from hexoses, produces in an apparently simple manner the more complicated carbohydrates. The beginning has already been made by the preparation of diglucose and of artificial dextrines; thus the chemical synthesis of starch, cellulose, inuline, gum, etc., is only a question of time.

It seems to me that organic synthesis which, thanks to the splendid methods which we inherited from the old masters, has, within the short period of sixty-two years, furnished: urea, the fats, many acids, bases and colors of the vegetable class, finally uric acid and sugars, need not shrink before any product of the living organism.

ABSTRACTS.

GENERAL CHEMISTRY.

Note on the Diamond. ALBERT KRAUSE.

The proof that diamond and carbon are identical has not heretofore been strictly defined. It has been shown only that the atomic weight is the same, and that on combustion a gas is furnished which precipitates baryta or lime water. Consequently it has not been shown to be impossible that diamond and carbon may be similar to each other, as nickel is to cobalt. An exact determination of the carbon dioxide formed in each case should decide the question. A derivative of carbon dioxide, obtained from diamond and from carbon, was tested in regard to such constants as melting point, solubility, form of crystals and power of conducting electricity.

As a result it was found that sodium carbonate prepared from diamond is absolutely identical with ordinary sodium carbonate. (*Ber. d. chem. Ges.*, **23**, *2409.*) L. H. F.

On Vanadium Sulpho Salts. KRÜSS and K. OHNMAIS.

Indications of the existence of vanadium sulpho salts existed previously. A series of beautifully crystallizing salts of this kind have now been prepared. (*Ber. d. chem. Ges.*, **23**, *2547.*)

L. H. F.

Researches on Beryllium. KRÜSS and MORAHT.

As a result of these researches the atomic weight of Be was found to be 9.028 if O = 15.96; or if O = 16 then Be = 9.05. (*Ber. d. chem. Ges.*, **23**, *2552.*) L. H. F.

The Constitution of some double salts of Rhodium. K. SEUBERT and K. KOBBÉ.

The following salts were prepared and analyzed: rhodium-potassium-chloride; rhodium sulphite with sodium sulphite,

rhodium sulphate with sodium sulphate. This last mentioned salt must be considered an anhydrous rhodium-alum of the formula: $Rh_2(SO_4)_3\,Na_2\,SO_4$. (*Ber. d. chem. Ges.*, **23**, *2556.*) L. H. F.

Splitting of Ammonium Nitrite by Means of Platinum Sponge. O. Loew.

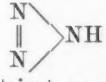
The facility of decomposition of ammonium nitrite, in aqueous solution (by warming) into nitrogen and water, decreases on increasing dilution. The more dilute the solution, the higher is the temperature required for decomposition, and thus very dilute solutions may be concentrated on the water bath to a certain degree without decomposition.

The author finds that, while a 4 to 5 per cent. solution, even on boiling is only slowly decomposed, this decomposition takes place at ordinary temperature in the presence of spongy platinum.

In a former paper it had been shown, that nitrogen in presence of strong alkalies and spongy platinum, reacts with water. Here we see the reverse action ; free bases being absent, platinum sponge causes the liberation of nitrogen with formation of water. (*Ber. d. chem. Ges.*, **24**, *3018.*) L. H. F.

On Hydrazoic Acid (Azoimide). Th. Curtius.

Hydrazoic acid, N_3H, a surprising analogue to halogen hydrides, is formed under certain conditions by the action of nitrous acid upon diamide, water being split off. It has the constitution :



It is to be expected that just as ammonia and nitrous acid furnish nitrogen, hydrazinmonochloride and nitrites would yield azoimide :

$$NH_4Cl + NO_2Na = N_2 + 2H_2O + Na\,Cl.$$

$$\begin{matrix} NH_2H\,Cl \\ | \\ NH_2 \end{matrix} + NO_2Na = N_3H + 2H_2O + Na\,Cl.$$

However, it seems to be difficult to prepare azoimide in this direct manner. On the other hand the study of reactions between

hydrazinhydrate and benzoylglycolic acid ester or hippuric acid ester lead to the discovery of this well characterized, easily prepared and interesting compound of nitrogen and hydrogen.

Organic derivatives of azoimide have long been known. Griess discovered the diazobenzolimide and E. Fischer prepared it from nitrosophenylhydrazin, this latter being the phenylester of hydrazoic acid.

Azoimide is a gas of a very remarkable, pungent odor. Even in a state of dilution it creates dizziness and headache, with inflammation of the mucous membrane of the nose. Its aqueous solution painfully cauterizes the epidermis.

Azoimide is a strong, monobasic acid, comparable in every respect to hydrochloric acid. Hence it may be called hydrazoic acid (Stickstoff-Wasserstoffsäure).

The gas is easily absorbed by water. On distilling this aqueous solution, a very concentrated aqueous acid passes over between 90° and 100° C. The first distillates of this contained about 27 per cent. hydrazoic acid. The aqueous solution, if not too dilute, has the odor of the gas. Blue litmus paper is colored intensely red when held above the liquid. Ammonia gas produces dense fumes of ammonium azide. A seven per cent. aqueous solution of hydrazoic acid dissolves iron, zinc, copper, aluminium, and magnesium, hydrogen being liberated violently. It seems that the concentrated acid also attacks gold and silver, since it turns red when in contact with both these metals.

The nitrogen metals (azides) thus formed, comparable are in every way to the metallic chlorides.

The metals of silver nitrate and mercurous nitrate are precipitated, even from dilute solutions, quantitatively as N_3Ag and $(N_3)_2Hg_2$. These reactions are used for the separation and purification of hydrazoic acid. Dilute sulphuric acid decomposes the solutions of all nitrogen metals, setting free the acid.

Silver azide was more closely studied. It differs from silver chloride only by its prominence under the influence of light.

Hydrazoic acid differs from halogen hydrides merely by its strong explosive properties which necessitate great precaution in handling it. The detonation caused by a few milligrammes of

silver azide or mercurous azide when heated or struck is unparalleled. A mere accident prevented the author being hurt when trying to enclose 2 c. c. of a 27 per cent. aqueous solution of azoimide in a specimen tube. The attempt to close the capillary end by fusion resulted in strong detonation reducing the thick glass vessel to powder. The sharpness of the sound, when a mere dust particle of silver azide is heated, is only comparable to the discharge of a Leyden jar.

The author is now beginning the study of reducing agents upon a nitrosamine which he obtained from hippuric acid. If it should be feasible (contrary to all observations heretofore made on nitroso compounds) to reduce the oxygen of the nitroso group, then it will be possible to split the amidohydrazin compound obtained into hippuric acid and *triamide:* $NH_2.NH.NH_2$, by boiling with acids. This triamide would be the "propane" of the hydronitrogen compounds. This body might again be condensed to substances richer in nitrogen. Introduction of nitroso groups into these, allowing a reduction to amido groups, would lead to a new chemistry of nitrogen compounds analogous to the chemistry of hydrocarbons of alcohol radicles. (*Ber. d. chem. Ges.*, **23**, *3023.*) L. H. F.

Preparation of Dry Diazo-Salts. E. Knoevenagel.

Avoid water, replacing it by alcohol. Instead of working with a current of free nitrous acid, use amyl nitrite in acid solution for diazotizing.—(*Ber. d. chem. Ges.*, **23**, *2994.*) L. H. F.

Formation of Urea from Albumen. E. Drechsel.

It was found by Lossen that on oxydizing albumen with alkaline permanganate solution, no urea, but small quantities of guanidine were formed. The author, studying the products of decomposition of caseïne found two new bases, lysatine and lysatinine, isomeric with creatine and creatinine. From these new bases he obtained urea by further treatment with baryta water.

His researches are of importance, since they show that urea is formed from albumen, simply by hydrolysis and without any oxidation.

Lysatine has subsequently also been formed from glue, and conglutine. (*Ber. d. chem. Ges.*, **23**, *3096.*) L. H. F.

A new Photographic Process. A. G. GREEN, C. F. CROSS and E. I. BEVAN.

The diazo compounds of dihydrothiotoluidine and its condensed derivatives when combined with the substance of animal or vegetable tissue are highly sensitive to light. A cotton or silk tissue dyed with primuline (1 to 2 per cent.) and sensitized by diazotizing of this latter, represents a photographic plate, able to yield a perfect "positive" in 40 to 180 seconds exposure. Thus a perfect reproduction of the original, in the shape of diazoprimuline, takes place. This picture then may be "developed" in form of any of the different colors which are formed from the above by combination with amines or phenoles. (*Ber. d. chem. Ges.*, **23**, *3131.*)

L. H. F.

On Fucose, from sea weed (Fucus), an isomer of Rhamnose. A. GÜNTHER and B. TOLLENS.

This crystallizable sugar from sea weed was obtained by the hydrazone reaction. It is very soluble, of sweet taste, crystalizes slowly, like laevulose, forms distinctly microscopic needles and plates, and has the identical composition of rhamnose: $C_6H_{12}O_5$.

Fucose rotates strongly to the left and, in the beginning, shows multi-rotation. On distilling it with HCl drops of methyl furfurol are formed. Alkaline copper solution is strongly reduced by fucose: (1 c. c. of Fehling's solution = 6 to 7 mgrms. fucose).

The melting point of its hydrazone is +170° C.; that of the osazone, about 159° C. Fucose is therefore isomeric, but entirely different from rhamnose. (*Ber. d. chem. Ges.*, **23**, *2585.*)

L. H. F.

A Quantitative Determination of Antimony according to Marsh's Test. A. VON BYLERT.

The author refers to the paper of Kuhn and Saeger (*Ber. d. chem. Ges.*, **23**, *1798*), and points out that Gautier (*Bull. Soc. Chim.*, **2**, *250, 1875*) founded a quantitative determination of arsenic upon Marsh's text.

In the determination of antimony, Marsh's method has been modified. Antimony was used in the form of alloys. These were dissolved in mercury and a liquid sodium amalgam, prepared by dis-

solving 5.5 grms. Na in 25 c. c. Hg, was added. Thus sodium-antimony is formed, which is decomposed by dilute sulphuric acid. Small quantities of antimony were thus determined in alloys of tin, silver, antimony.—(*Ber. d. chem. Ges.*, **23**, *2968.*) L. H. F.

Experiments for quantitative determination of arsenic by Marsh's test. Behavior of arsine towards potassium hydrate. B. KUHN and O. SAEGER.

An abstract of this paper is to be found in *Jour. Amer. Chem. Soc.*, **12**, *353.* In regard to the behavior of arsine towards potassium hydrate it must be stated that R. O. Doremus has drawn attention to this fact, as observed by him, long ago. See: Fresenius quantitative analysis. Allen and Johnson's Translation. John Wiley & Sons, New York, 1881, p. 782. L. H. F.

Determination of Carbon in Organic Compounds, in the Wet Way. J. MESSINGER.

In an apparatus of peculiar construction, made by Cornelius Heinz, in Aix-la-Chapelle (Aachen). the determination of carbon in organic compounds is performed by means of chromic acid and conc. sulphuric acid. (*Ber. d. chem. Ges.*, **23**, *2756.*) L. H. F.

A Method for the Quantitative Determination of Camphor. F. FOERSTER.

Substances occur in the trade consisting of nitrocellulose and camphor. Both substances are very intimately combined in these horn or ivory-like masses. Such substances are decomposed by means of sodium hydrate solution and subjected to distillation. Thus the camphor is driven off. The distillate is shaken with a measured quantity of benzol, and the rotation of the solution obtained is determined.—(*Ber. d. chem. Ges.*, **23**, *2981.*) L. H. F.

Volumetric Determination of Phenols. I. MESSINGER and G. VORTMANN.

In a former paper (*Ber. d. Chem. Ges.*, **22**, *2312.*) the authors have described a new class of bodies formed by the reaction of iodine upon an alkaline solution of phenols. This reaction has now been developed into a mode of quantitative determination (volumetrically) of phenol, thymol, naphthol and salicylic acid. (*Ber. d. chem. Ges.*, **23**, *2753.*) L. H. F.

Abstracts of American Patents Relating to Chemistry.

(*From the U. S. Patent Office Gazette.*)

Issued November 18, 1890.

440,639.—Blue black azo dye. R. Lanch and M. Kahn.

Violet to blue black dye stuffs, consisting of diazotized tetrazo compounds or naphthols (dioxynaphthalines), said dye stuffs being soluble in hot water and insoluble in benzine and alcohol, and having the property of dyeing cotton without a mordant.

440,752.—Apparatus for preparing extract of coffee. H. Barotte.

440,754.—Art of manufacturing illuminating gas. E. Beauharnais.

440,772.—Preparing yeast. E. Leconte.

A method of revivifying and removing the bitterness from brewers' yeast to fit the same for bread making, which consists in diluting the yeast with warm water and adding maltine or extract of malt.

440,777.—Process of obtaining oxygen. F. Salomon.

Consists in heating a mixture of a metallic oxide, such as lead monoxide or lead carbonate, and of an alkaline earth, such as lime, in a current of air, so as to cause oxygen to be absorbed, and then driving off the oxygen by a current of carbon dioxide.

440,792.—Process of making hydrogen peroxide. W. Erwin.

440,830.—Process of treating coal tar. A. L. Munson.

The tar is heated to 110° F, and thoroughly combined with a solution of zinc chloride and oil of turpentine.

440,921.—Explosive. D. Mindeleff.

Consists ethyl nitrate, methyl nitrate, nitrobenzol, methyl alcohol, pyroxyline, and nitroglycerine.

440,946.—Welding compound. T. Durrant.

Consists of borax, brick or marble dust, potassium bicarbonate, and salts of tartar.

440,950.—Apparatus for manufacturing heating or fuel gas. A. Kitson.

440,952.—Manufacture of compound aluminium plates. C. H. Land.

440,953.—Blue dye. W. Majert.

The process of preparing consists in melting alphanaphthyldis ulpho acid with caustic soda or potash, then treating the dioxynaphthaline so obtained with concentrated or fuming sulphuric acid, or sulphuric chlorhydrin, and then adding the sulpho acid of dioxynaphthaline so obtained to tetrazodiphenyl chloride in presence of sodium carbonate.

440,963.—Apparatus for extracting grease from wool. L. Pinagel.

440,968.—Carbonizing apparatus. A. Silverberg and C. Detering.

441,010.—Leather dressing. J. M. Jolly.

Consists of neat's foot oil, water, beeswax, logwood extract, gum arabic, petrolatum, borax, oil of citronella and castile soap.

441,075.—Paint. J. Smith.

Consists of white lead, linseed oil, whiting, sulphate of lime, alum, glue, driers and water.

441,076.—Apparatus for producing white sugar. C. Steffen.

441,102.—Process of reducing iron ores. H. W. Last and J. Johnson.

Iron is reduced directly from the ore, by grinding the moistened ore and carbonaceous material together into a pulverized homogeneous mass, spreading the paste thus formed in the hearth of a furnace, covering the charge with a mixture of pulverized glass and carbon, and then subjecting the mass to heat to effect the reduction.

Issued November 25, 1890.

441,163.—Non-conducting sheet or mass. H. W. Johns.

Consists of fibrous or comminuted sponge, and horn blende, mineral wool, the oxides of the metals, and the like bodies, and antiseptic or disinfecting material.

441,164.—Fireproofing compound. H. W. Johns.

Consists of borax, boric acid and zinc oxide.

441,165.—Non-conducting covering. H. W. Johns.

Composed of a major part of wood pulp mixed with infusorial earth, magnesia or like material and with straw, sponge, or like porous of fibrous material and with a layer of fireproofing material between the covering and the surface to be protected.

441,166.—Process of reducing ore. J. Johnson.

Iron is reduced direct from the ore, by charging the ore onto the hearth of a suitable furnace, subjecting it to a reducing heat, adding dampened pulverized carbonaceous material to the charge and rabbling or stirring it into the hot ore, and then subjecting the entire charge to a reducing heat.

441,174.—Process of manufacturing carburized metal. H. W. Last and J. Johnson.

Ore and carbonaceous material are reduced to a homogeneous pasty mass, which with a carbonaceous fuel is charged into a cupola furnace.

441,180.—Making peptones. V. Marcano.

Finely chopped meat is subjected to the action of a vegetable ferment until peptonization takes place, after which the peptonized meat is dissolved in water and filtered.

441,181.—Making peptonized meat. V. Marcano.

The process consists in subjecting finely chopped meat to the action of the organic vegetable ferments contained in the juice expressed from the

plants belonging to the family of *Bromeliaceas* until peptonization takes place, then evaporating and drying the liquid peptonized meat, and grinding it into powder.

441,182.—Making vegetable pepsin. V. Marcano.

The juice from *Bromeliaceous* plants is evaporated at a temperature not exceeding 45° C to a density of 40° B and precipitated with alcohol.

441,284.—Chemical feeder for filters. B. H. Coffey.

441,290.—Anti-fouling paint. M. E. Dejonge.

Consists of zinc dust suspended in a vehicle of a solution of shellac and colophony in fusel oil.

441,291.—Anti-corrosive and anti-fouling compound. M. E. Dejonge.

Consists of colophony, paraffin oil, paraffin and zinc dust.

441,292.—Anti-fouling paint. M. E. Dejonge.

Consists of paraffin, zinc dust and agalite.

441,366.—Process of hardening resins. A. Kissel.

Colophony and like inferior resins are hardened by first melting the resin with an oxide to neutralize the free resinous acid normally existing in the resin, and forming a hardened resin ; second, treating the hardened resin thus formed with a soluble chemical to convert resinous acid generated or liberated in melting the resin into a soluble salt ; and, lastly, separating the soluble resinate from the hardened resin.

441,462.—Method of treating parchmentized fibre waste. J. W. Barnes.

441,501.—Process of manufacturing rubber goods. G. C. Mandleberg, H. L. Rothband and S. L. Mandleberg.

441,502.—Process of manufacturing rubber goods. G. C. Mandleberg, H. L. Rothband and S. L. Mandleberg.

441,503.—Process of manufacturing rubber goods. G. C. Mandleberg, H. L. Rothband and S. L. Mandleberg.

441,514.—Manufacture of translucent enamel. J. Valére.

Consists of minium, boric acid, zinc oxide, stannic oxide, clean sand, soda, feldspar, fluor spar, potassium carbonate, calcium carbonate, borax sodium nitrate, and a suitable flux.

W. R.